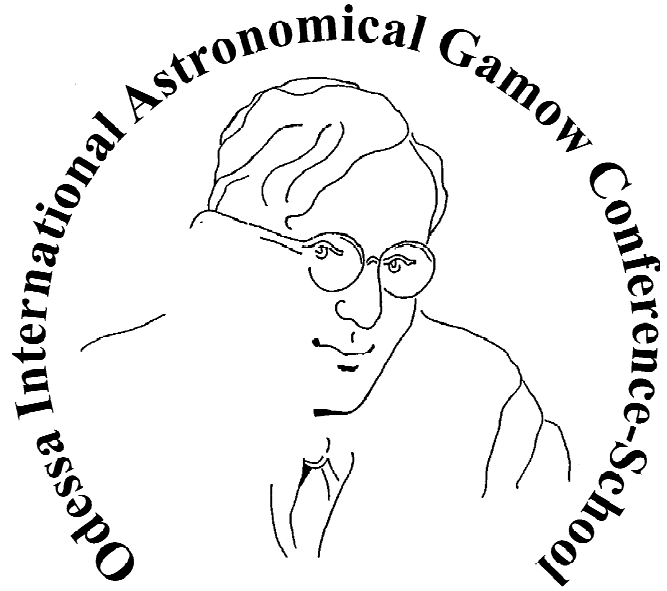
22-nd Gamow International Astronomical Conference "ASTRONOMY AND BEYOND: ASTROPHYSICS, COSMOLOGY AND GRAVITATION, ASTROPARTICLE PHYSICS, RADIO ASTRONOMY AND ASTROBIOLOGY"



ABSTRACTS

August 22-26, 2022
Odessa, Ukraine

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"ASTRONOMY AND BEYOND: ASTROPHYSICS, COSMOLOGY AND GRAVITATION, ASTROPARTICLE PHYSICS, RADIOASTRONOMY AND ASTROBIOLOGY"
ABSTRACTS
Англійською та українською мовами

22-nd Gamow International Astronomical Conference

"Astronomy and beyond: Astrophysics, Cosmology and Gravitation, Astroparticle Physics, Radioastronomy and Astrobiology"

(August 22-26, 2022, Odesa, Ukraine)

MEMORIAL SESSIONS

PROF. VLADIMIR PLATONOVICH TSESEVICH (1907-1983): SCIENCE, EDUCATION, ORGANIZATION OF SCIENCE, PUBLIC OUTREACH

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Vladimir Platonovich Tsesevich (11.10.1907–28.10.1983) was a great person. Particularly, he was a head of the Astronomy in the Odessa State (now National) University named after I.I.Mechnikov in 1944-1983, combining positiond of the Director of the Astronomical Observatory and the Chair of the Department of Astronomy. At the age almost 15, he had become a University student and started to observe variable stars, which was his main scientific direction during all the life. The number of his small and large publications reached 760 (!!!). The first scientific notes by other scientists based on the observations by V.P.Tsesevich were published exactly 100 years ago, in 1922. The first own publication based on his own observations was published in 1923, and in 1924, already 10 (!!!) publications appeared in the oldest astronomical journal "Astronomische Nachrichten" (founded in 1821 – also a remarkable date last year). In 1933-1937, he was a Director of the Tadjik Astronomical Observatory (now Institute of Astrophysics). In 1948-1950, he was also a Director of the Main Astronomical Observatory of the Ukrainian Academy of Sciences.

He wrote once that "the science of variable stars is still an area of astronomy that is accessible to amateurs. It is here, in this area of astronomy, that the amateur can obtain valuable results. You just need to observe and carefully process your observations". In recent decades, many national and international conferences are organized in developed countries with a label "ProAm" (Professional-Amateur). He has made ~400 000 visual/photographic observations of variable stars of different types, understanding importance of careful studies of stars at this active evolutionary stage. Having a great experience in visual observations, he inspired others to provide scientific regular observations rather than only enjoying by seeing or photographing beautiful space views. The list of his publications includes 22 monographs, some of them are "popular" (Public Outreach) for high-level amateur astronomers and simply advanced readers. Many of them have become scientists, engineers and specialists of various directions. They remember exciting popular lectures and books, which lead them to Science. The main popular book "What and How to Observe in the Sky" had 6 editions, the last one was published in 1984, after his death.

Hundreds of people attracted to science (not only astronomers and mathematicians)

Two of these monographs were translated into English, namely, "RR Lyr-type stars" (1966) and "Eclipsing variable stars" (1971). They are in "must have" lists of corresponding scientists. He read lectures on Relativistic Astrophysics, Mathematical Physics et al. for students-astronomers, and also on different branches of Higher Mathematics in some institutes (now National Universities) in Odessa, including OIIMF/ONMU in 1952-1967.

The year 1957 was declared as the International Geophysical Year by UNESCO. This inspired creation and improvement of astronomical observatories. V.P.Tsesevich organized two sub-urban observational stations in Mayaki and Kryzhanovka to create the all-country "Bolid net" (together with E.N.Kramer). Observations of satellites was carried out. However, in Mayaki was installed a 7-camera Astrograph – 7 small telescopes to make pg and pv exposures of wide fields to study variable stars, sometimes, asteroids. This was a great project. The number of photoplates obtained during 30 years of its work exceeds 100,000 and is the third in the world after the Harvard (USA) and Sonneberg (Germany) "Sky Patrol" plate collections.

V.P.Tsesevich was a supervisor of 41 PhDs. Last PhD Theses were defended by N.I.Koshkin and I.L.Andronov. who continue a scientific school in different directions – "Small Bodies of the Solar System" and "Variable Stars". Very active directions of astronomy in Odessa are Astrophysics (Drs. Sci. T.V.Mishenina, V.V.Kovtiukh, S.M.Andrievsky, D.N.Doikov) and Cosmology and Extra-Galactic Astronomy (Drs. Sci. A.I.Zhuk, E.A.Pan`ko). Previosly, there was an important department of building telescopes (L.S.Paulin and N.N.Fashchevsky), the largest ones are 1m and 80cm.

After V.P.Tsesevich, the Directors of the Astronomical Observatory were (in 1983-1988) Yu.A.Medvedev, (in

1988-2016) V.G.Karetnikov, (in 2016-2021) S.M.Andrievsky and (from 2021) N.I.Koshkin. Many active “scientific grandchildren” work in Odessa, Ukraine, and other countries.

The memory of Prof V.P.Tsesevich lives in our hearts.

FROM SPECTROSCOPY TO THE CHEMICAL EVOLUTION OF THE MILKY WAY. PART 1. TO MARK THE 150TH ANNIVERSARY OF THE ODESA ASTRONOMICAL OBSERVATORY.

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This review provides a brief summary of the results obtained at the Odesa Astronomical Observatory, based on spectral analysis, starting from the first observations of emission lines in solar prominences in 1892 carried out under the direction of Alexander Kononovich. It includes an overview of spectrophotometric studies performed at the observatory using instruments and telescopes designed in-house; theoretical consideration of the issues of modelling physical conditions in stars and spectra simulation; the main important results in the research of stars of various types, including cool M giants, K giants, stars with various peculiarities of chemical composition, such as enhanced lines of metals and CN bands, eclipsing binaries, long-period variable stars, RR Lyraes, Delta Scuti and Lambda Boötes type stars, the diversity of Cepheids, blue stragglers in field and cluster populations, hot B main-sequence stars, and finally, the enrichment with neutron-capture elements in the galactic stars.

LIFE AND SCIENTIFIC ACTIVITY OF GEORGE GAMOW

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Simon Mitton studied Physics at Oxford, and on graduating in 1968 began his doctoral studies in radio astronomy at the Cavendish Laboratory, University of Cambridge. The advisor with whom he worked most closely was Martin Ryle, Nobel Laureate in Physics 1974. Dr. Mitton was a postdoc at the Institute of astronomy, Cambridge from 1972 to 1978. He worked for Cambridge University Press for 22 years, during much of which he directed a large publishing program in Science, Technology and Medicine. On retirement from the Press, he took up a new career as a historian of science, notably the history of cosmology in the twentieth century. He has written extensively on the cosmologists Fred Hoyle and Georges Lemaître, and this morning he will be speaking on the life and science of George Gamow.

George Gamow led an extraordinary and excited life in science that is difficult to summarise, let along appreciate, in this short presentation. The narrative begins in Odessa, his place of birth, where he enrolled at the university to study mathematics in 1921. From 1922 to 1928 he was at St Petersburg deeply immersed in research in physics, specialising in the new wave mechanics. In 1928 he moved to Göttingen where he made the spectacular discovery of quantum mechanical tunnelling, which put him in the first rank pf physics overnight. From 1929 he worked in nuclear astrophysics, which resulting in him coming into conflict with prevailing Soviet philosophy. In despair, in 1933 he and his wife abandoned Russia for good. In 1934 he accepted a professorship at George Washington University in Washington DC. From then on, he worked tirelessly on nuclear astrophysics and cosmology. His most famous doctoral student was Ralph Alpher, who in 1948 suggested that the Big Bang might resulted in a cosmic microwave background. My recent study of Gamow’s handwritten letters to Alpher from 1948 to 1957 has enabled me to construct the history of Gamow’s life and thoughts from the end of WWII to his death in 1968.

A FASCINATING STORY OF THE DISCOVERY OF A NON-STATIONARY UNIVERSE: FROM A GREAT "BLUNDER" TO EXPERIMENTAL CONFIRMATION

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Today it is well known that our universe is expanding. However, even 100 years ago, the notion of a static universe was considered correct. In my talk, I will tell a fascinating story about how a few great men have changed our mind.

PLENARY SPEAKERS

ASTROINFORMATICS: WAVELET ANALYSIS OF IRREGULARLY SPACED DATA

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Wavelet analysis is one of the important tools for the mathematical modeling of the signals of any nature, i.e. the Time Series Analysis (TSA) and the Data Analysis (DA). The specifics of (not only) astronomical signals is irregularity of arguments (e.g. gaps, non-uniform distribution), which is typical for e.g. photometrical surveys obtained at ground-based and space observatories. Thus the typical methods, which apply the Fast Fourier Transform (FFT) to the signal, multiplication by the FFT of weight (filter) functions, and a further inverse FFT have no sense because of the alias peaks at the spectral window. Thus a weighted least squares local approximation, which depends on a shift and scale, was discussed in 1998KPCB...14..374A (see also more recent reviews 2003ASPC..292..391A and 2020kdbd.book..191A), with test-functions WWA, WWZ, which have unwanted asymptotic behavior of -1 for small periods and +1 for large periods, respectively. An improvement may be done as a weighted analog of the test function S(f) used in the periodogram analysis. Next improvement is in usage of a local weight function instead of a formally infinite Gaussian function. We applied a bi-square weight function similarly to the scalegram analysis using the "Running Parabola" method (1997A%26AS..125..207A).

Here we comparatively review effectiveness and accuracy of different weight functions (tri-cubic, tetra-square, B-spline and classical Gaussian) using test signals and a group of long-periodic variables (LPV) of different subtypes.

COSMOLOGICAL PERTURBATIONS ENGENDERED BY DISCRETE RELATIVISTIC SPECIES

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Within the extension of the LambdaCDM model, allowing for the presence of neutrinos or warm dark matter, we develop the analytical cosmological perturbation theory. It covers all spatial scales where the weak gravitational field regime represents a valid approximation. Discrete particles – the sources of the inhomogeneous gravitational field – may be relativistic. Similarly to the previously investigated case of nonrelativistic matter, the Yukawa interaction range is naturally incorporated into the first-order scalar metric corrections.

THE FIRST MOLECULES IN THE HALOS OF DARK AGES AND COSMIC DAWN: CONTENT AND LUMINESCENCE

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We study the formation/destruction of the first molecules at the Dark Ages and Cosmic Dawn epochs in order to evaluate the luminosity of the protogalaxy clumps (halos) in the molecular lines using the relevant basic kinetic equations. The effect of collisional and radiative excitation of molecules on the intensity of molecular emission has been studied in both warm and hot halos. Using the Planck data on the reionization of the intergalactic medium at z~6-8 we evaluate the light energy density of the first sources that appeared in the Cosmic Dawn epoch. We estimate the impact of the light of the first sources on the formation/destruction of the first molecules in halos as well as between them. We show that molecules H_2 and HD are destroyed by photodissociation processes shortly before the complete reionization. While the number density of helium hydride ions, HeH^+, shows essentially more complicated dependences on kinetic temperature of halos and the models of the first light. These features of the abundance of molecules determine the intensity of the halos luminescence during their evolution. We have calculated the evolution of the brightness temperature of the individual halos in the rotational lines of H_2, HD and HeH^+ molecules relative to the temperature of the cosmic microwave background at redshifts corresponding to the Dark Ages and Cosmic Dawn epochs. It does not exceed microkelvins, but its detection may be an important source of information about physical processes at the epoch of the formation of the first stars and galaxies.

SPACE AND GROUND-BASED STUDY OF THE SUN NOW AND IN NEAR FUTURE

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The scientific goal of the talk is to review the present and future advances in solar physics due to solar space

missions and the development of new ground-based telescopes. We give a short overview of research of the Sun with help of spacecraft launched since1962. We present the most important of them such as OSO, Pioneer, Helios, SMM, Ulysses, SOHO, CORONAS, RHESSI, Hinode, STEREO and SDO. We focus on the latest solar mission named Solar Orbiter. It is the first mission observing the solar plasma both in situ and remotely, from a close distance, in and out of the ecliptic. The ultimate goal of this mision is to understand how the Sun produces and controls the heliosphere, filling the Solar System and driving the planetary environments.

We review also the future advances in solar physics due to the development of new ground-based telescopes with large aperture and with new optical tools. They are: the 4-m Daniel K. Inouye Solar Telescope (DKIST), the 4-m European Solar Telescope (EST) and the 1.5-m GREGOR solar telescope. At the end, we discuss what we can expect from solar studies in Ukraine.

DARK MATTER AS A MANIFESTATION OF GRAVITY

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The Standard Model of particle physics does not have a candidate for a dark-matter particle. Most of existing dark-matter candidates are introduced as new quantum fields in the matter part of Lagrangian. In this talk, we discuss a different perspective, in which dark matter arises from the gravity sector. Specifically, we show that the additional scalar degree of freedom (the scalaron) of the metric $f(R)$ gravity can be a good candidate for dark matter if its mass is in the range between several meV and MeV. We give an overview of such $f(R)$ gravity theory minimally coupled to the Standard Model of particle physics and discuss the initial conditions for the scalaron. Firstly, these initial conditions are to be tuned in order to produce the observed amount of dark matter. Secondly, the primordial spatial inhomogeneities in the scalaron field are to be sufficiently small because they generate entropy (or isocurvature) perturbations, which are constrained by observations. We point out that the homogeneous part of the scalaron initial value is largely unpredictable because of quantum diffusion during inflation. Thus, to account for the observed amount of dark matter, one has to resort to anthropic considerations. Observational constraints on the primordial spatial inhomogeneity of the scalaron give upper bounds on the energy scale of inflation, which happen to be low but not too restrictive. The whole theory could be probed by searching for the additional Yukawa gravitational force caused by the scalaron at sub-millimetre spatial distances.

THE MAIN OBJECTIVES OF GROUND BASED OBSERVATIONAL ASTRONOMY FOR THE NEXT DECADE

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Ground based observational astronomy of the next decade will be characterised by the entry in service of unprecedented observational infrastructures across the entire multi-messenger domain. From the Radio-wavelength of SKA to the Tera-EV extreme universe of CTA through the optical-infrared of ELT, our knowledge of electromagnetic cosmic sources is expected to consistently increase. New generation neutrinos detectors like KM3 or Gravitational waves telescope like ET will complement the electromagnetic spectrum observations allowing an unprecedented insight in tour comprehension of the universe. We review in this paper which are the major goals we should reasonably expect to achieve and the areas in which major enlightenments are foreseeable.

COSMOLOGY, GRAVITATION, HIGH ENERGY PHYSICS, ASTROPARTICLE PHYSICS

GRAPHITE UNIVERSE MODEL

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Until now there is no clear idea about the details of large-scale structure of the universe, especially about the location of filaments. Therefore, in this work we propose a new model of so called "graphite universe" that can help in its further study. We suppose that the picture of galaxy filaments at certain redshift should be similar to hexagonal grid. So all voids should be identical hexagons and all filaments should be also identical. The purpose of the work is to present and verify this model of the structure of the universe based on the SDSS data. Our task is determination of the number of galaxies in filaments for various parameters of the graphite universe model.

We downloaded from the SDSS database the position of galaxies in one radial layer with a width of 100 Mpc.

To test the model, we compare the number of galaxies in voids and filaments. We consider the circular central part of the hexagon to be the void, and the remaining area of the hexagon to be the surrounding filaments. Thus, the task is reduced to counting the number of galaxies in circles distributed on a hexagonal grid.

We wrote a program that calculates the number of galaxies in voids and filaments in the graphite universe. Our program determines the coordinates of the centers of the voids and compares them with the positions of the galaxies. This makes it possible to count the number of galaxies in voids and filaments.

As a result of our calculations, we found fluctuations in the number of filaments with maxima corresponding to cell diameters of 15, 23, 32, 45 degrees. Therefore, it can be said that this model quite truthfully describes the structure of our universe.

CHIMNEY AND SLAB TOPOLOGIES: GRAVITATIONAL INTERACTIONS IN LATTICE UNIVERSE

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We present the study of gravitational potentials generated by point-like massive objects and influenced by the Slab ($T\times R\times R$) and Chimney ($T\times T\times R$) topologies of the Universe. Several distinct forms of solution are obtained for both cases: (1) from Fourier expansion of delta functions into series using periodicity in one and two toroidal dimensions for Slab and Chimney topologies, respectively; (2) the summation of solutions of the Helmholtz equation for a source particle and all its images, which take the form of Yukawa potentials. In addition, in the case of Chimney topology, we also obtain the third alternative solution for the potential via the Ewald sums method applied to Yukawa-type potentials. Finally, we show that the formulas containing simple summation of Yukawa-type potentials are preferable for computational purposes for the present Universe since they need fewer terms in the series to reach adequate precision.

GROWTH OF GALAXIES BY DARK MATTER PARTICLE CAPTURE

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Dark matter (DM) particle velocities increase as they enter from intergalactic space into the halo of the galaxy and decrease as they leave. If during the flight the mass of the galaxy has increased, then slow DM particles are captured by the galaxy, further increasing its mass, while faster particles slow down, transferring part of their energy to the galaxy. A simple model describes this process. It allows one to estimate the minimum initial velocity of a particle required for a passage without capture through the center of the galaxy and the rate of galaxy mass increase. An analysis carried out using the ideas of the theory of catastrophes shows that for intensive capture of dark matter, an increase in the mass of galactic baryonic matter is necessary, exceeding a certain threshold value in the present or past. It may be associated with the accretion of matter or the merger of galaxies. Additionally, the density of intergalactic DM must exceed the threshold value. Then the rate of increase in the mass of DM can be many times higher than one for the baryonic matter. The capture rate sharply decreases after the DM density decreases below the threshold value due to expansion.

GALACTIC COSMIC RAY TRANSPORT IN HELIOSPHERE IN THE SMALL ANISOTROPY APPROXIMATION

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The propagation of cosmic rays in the interplanetary medium based on the transport equation is considered.

The method for the approximate transport equation solution taking into account the small value of cosmic ray anisotropy is applied. The solution of cosmic ray transport equation is obtained under known energetic particle distribution at heliopause. The energetic spectrum of galactic cosmic rays in the local interstellar medium is taken on the basis of the data from Voyager spacecrafts, which explored remote regions of the heliosphere. The flux density of galactic cosmic rays is calculated in different periods of solar activity. Cosmic ray intensity gradients are evaluated and these estimations are compared to the space mission data. It is shown that the flux of galactic comic rays at the Earth's orbit has an azimuthal direction, the value of the anisotropy of protons with energies from 1 MeV to 1 GeV is almost independent of particle energy and is of the order of 0.5%.

SPHERICALLY SYMMETRIC SYSTEM OF GRAVITATIONAL AND ELECTROMAGNETIC FIELDS AND THE STRUCTURE OF ITS CONFIGURATION SPACE

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The papers [1] consider BH models based on the spherically symmetric system of Einstein-Maxwell equations in the T-region. The conservation laws of charge Q and mass M with the Hamiltonian constrain, determine the momenta and the action of the system in terms of Q and M, and field variables. It is shown that the configuration space (CS) is flat. When quantizing a system, we use the natural measure to construct the Hermitian DeWitt (Laplace-Beltrami) and mass operators. The wave function of the model follows from the self-consistent solution of the DeWitt equations and equations for the eigenvalues of the mass and charge operators. This construction it considered as a quantum T-model of a BH with a continuous spectrum of mass and charge.

We consider a more general system in [2], when the model includes R and T-regions The CS metric of this system admits the integrals of motion: M and Q, which with the Hamiltonian constraint lead to the momenta as the functions of the configuration variables. The relations $\delta S/\delta qi$ lead to a functional S depending on Q and M and field variables as a solution to the Einstein-Hamilton-Jacobi equation.

In this article, we study the correspondences between the CS structures of these models for the subsequent quantization of the T-R model. For example, the CS metrics of both models are flat. This defines a Hamiltonian quantum operator leading to the Laplace-Beltrami operator, which is Hermitian with respect to the natural measure on the CS. This also defines a mass operator with the corresponding ordering.

1. Gladush V.D. J. Phys and Electron, 2021, 29(2), 21; Odessa Astron. Publ., 2021, 34, 11.
2. Gladush V.D. J. Phys and Electron, 2019, 27(1), 3; Odessa Astron. Publ., 2019, 32, 35.

THE INVESTIGATION OF THE SUBSTRUCTURES IN THE ISOLATED GALAXY CLUSTERS

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In our research, we investigated the substructures in the field of isolated galaxy clusters, i.e., those whose distance to the neighboring cluster is greater than 50 h^{-1} Mpc. They evolve most simply and the interaction between hot gas, dark matter, and galaxies must happen in the same way as in the overdense regions in the Universe, thus, the study of these objects is relevant and will expand our knowledge about early stage formations in the Universe.

Our data set contains 19 isolated clusters of galaxies from the PF catalogue (Panko & Flin, 2006), which was based on the data from the Muenster Red Sky Survey (Ungruhe et al., 2003). From these clusters, we excluded those which do not have significant features (overdense regions) and marked them as O-type clusters according to the Panko classification scheme (Panko, 2013). For those which have some linear overdensities, we investigated the orientation of the galaxies in them. Thus, we found 4 clusters having the features, such as filamental substructure (in 2 clusters), the possible wall case (in 1 cluster), and cross (in 1 cluster). Our results confirm different both simple and complex ways of the evolution of galaxy clusters as the element of the large-scale structures in the Universe.

Panko E., P. Flin *J. Astron. Data*, **12**, 1 (2006)
Panko E., *Odessa Astron. Publ.*, **26**, 90 (2013)
Ungruhe R., Seitter W.C., Duerbeck H.W. *J. Astron. Data*, **9**, 1 (2003)

GRAVITATIONAL PROPERTIES OF OUTER POTENTIAL OF A TORUS WITH AN ELLIPTICAL CROSS-SECTION

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Toroidal (or ring) structures are a key element of some astrophysical objects: dusty tori in active galactic nuclei (AGNs), ring galaxies, protoplanetary disks, ect. The mass of torus can be large enough to influence on the dynamics of matter around. N-body simulations of the torus in the field of a central mass demonstrate that its cross-section in equilibrium state depends on the initial condition and it has elliptical or oval shapes (Bannikova et al. 2021). In this work we investigate outer gravitational potential of the torus with elliptical cross-section. We use

for this the integral expression for the torus potential in any point obtained in (Bannikova et al. 2011). We have considered the series expansion in vicinity of the massive circle with radius equal to the major radius of the torus located in the equatorial plane. Limiting up to the second power terms, we have obtained the approximate expression for the outer potential of the torus which is robust for wight range of cross-section ellipticity parameters. One of the interesting result is the representation of the torus potential by two massive circles located in the equatorial plane at some distance from the cross-section focuses. We have also obtained the corresponding approximate expression and considered the limited case of the circle torus. These approximate expressions have a good agreement with exact potential which is proofed by error maps. Obtained expressions allow us to use them for the following investigation of dynamics in systems with toroidal structures.

Bannikova E.Yu, Sergeev A.V., Akerman N.A., Berczik P.P., Ishchenko and Capaccioli M. 2021, MNRAS, 503, 1459
Bannikova E.Yu., Vakulik V.G., Shulga V. 2011, MNRAS, 411, 557

CIRCULAR ORBITS AROUND STATIC SPHERICALLY SYMMETRIC CONFIGURATIONS WITH SCALAR FIELDS IN GENERAL RELATIVITY

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We study circular orbits (CO) of test particles around static spherically symmetric configurations in General Relativity with scalar field (SF). The focus is on the non-connected distributions of stable CO, where the different regions of the latter are separated by rings of the unstable CO. The minimally coupled SFs are considered with different monomial potentials, including massive linear SF. The existence and uniqueness of solutions of the Einstein-SF equations under usual asymptotic at spatial infinity are considered. We show that in the case of the sufficiently high non-linearity, the qualitative properties of the CO distributions have much in common with the case of Fisher-Janis-Newman-Winicour metric (FJNW) dealing with the massless linear SF. However, for some configuration parameters, there are topologically different CO distributions, which are not present in the case of FJNW. We present images of thin accretion disks taking into account the redshift and form of the stable SO distributions. Relevance to the accretion disk images for M87* and SgrA* observed with the Event Horison Telescope is discussed.

NEW APPROACH TO DECOUPLING OF THE MAXWELL EQUATIONS

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Astrophysical objects, such as black holes, neutron stars etc. generate strong gravitational field, and the general relativity theory must be used to describe electromagnetic field propagation in their vicinity.

The Maxwell equations in the pseudo-Riemannian space of general relativity are a strongly coupled system of the first order PDEs. Decoupling methods for such system were developed by Teukolsky (1973), Cohen, Kegeles (1974, 1979), and Stewart (1979). To realize a decoupling scheme less general space-time or/and less general Maxwell field is often considered.

We assume that the Maxwell field is null, which means that both electromagnetic invariants are equal to zero. In other words, we consider only electromagnetic waves (far field). Our decoupling scheme for such Maxwell field is developed for the Petrov type D space-times. Decoupled equations are the first-order quasilinear PDEs. We also apply the Teukolsky form of solution to equations in the Kerr space-time and obtaine a more simple (2-dimensional) decoupled system.

CORRELATIONS BETWEEN NETWORK METRICS AND PHYSICAL PROPERTIES OF HALOS IN COSMIC WEB IN COSMOLOGICAL SIMULATIONS

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In our work we explore network metrics of Cosmic web, formed in high-resolution cosmological simulation and compute their correlations to physical properties of halos, of which the web consist. We used Enzo's simulation code, which is known to have high spacial resolution, in this case equal to 160 kpc, to perform the simulation. The size of cube was 85 Mpc with 512^3 particles in it. Rockstar FOF halo finder found approximately 12900 halos in 1.5×10^8 – 1.5×10^{13} $M_\odot/h$ mass range. A number of physical characteristics of halos are also modeled, such as temperature, magnetic field and spin parameter. We compute different metrics for the network they form, for example, betweeness, closeness, eigen, Katz centralities and others and the we find correlations between physical values and the metrics. We also consider linear regression as the simplest model to predict the physical characteristics with computed network metrics.

COSMIC SCREENING APPORACH IN FULLY PERIODIC BOUNDARIES

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Conventionally, N-body codes of structure formation rely on periodic boundaries while solving for the gravitational force so that the outcomes better comply with the dynamics in the infinite universe of concordance cosmology. Still, other topologies are not ruled out by theory (i.e. general relativity) and certain observational findings may be attributed to the existence of domains other than the simply-connected zero-curvature space. For a multiply connected universe, the space could have the form of a finite-size cubic torus and thus a periodic formulation of gravitational potentials and forces would still be relevant, now from the point of view of the actual physical setting. Given such motivation, we solve the Helmholtz equation from [1] for the gravitational potential in a fully periodic cubic domain and compare the resulting three alternative expressions in view of numerical efficiency [2]. We repeat the process for the corresponding force expressions. We also study the extent of backreaction effects on the homogeneous background, again, with respect to numerical computations, as well as their relation to the screening length of Yukawa gravity. Finally, we compare the evolution of Yukawa and Newtonian forces in the same domain to point out where in the box they begin to differ significantly from one another [3].

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ASTROPHYSICS

(stellar atmospheres, interacting binary systems, variable stars)

DISCOVERY OF A NEW [WR] STAR J040901

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Wolf–Rayet (WR) stars are evolved massive objects, famous for their spectra rich by emission lines. For the first time WR stars were described more than 150 years ago, and now in our Galaxy we know around 667 objects of this type. However, the discovery of new WR star, especially based on spectral observations, is still a rare event. The poster will be devoted to J040901 star, discovered a few years ago as WR star in LAMOST spectral survey by machine learning methods. We were interested that different researchers based on different methods classify this object in different ways – ranging from RR Lyr variable to nitrogen rich WR – and we began our study. We combined spectral and archival photometric data, analysed the spatial location of the star in the Galaxy and concluded what J040901 is [WR] – central star of planetary nebulae. The poster will show all details of our study and fully outline the way we used to reach this conclusion.

MAPPING THE KINEMATIC PARAMETERS OF THE GALAXY FROM THE GAIA EDR3 DATA

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We present the results of a kinematic analysis of red giants and subgiants whose centroids are in the plane of our Galaxy. For this, the positions, parallaxes, proper motions, and radial velocities of these stars from the Gaia EDR3 catalogue were used. We applied two approaches to obtain kinematic parameters. The first approach – solving the equations of the Ogorodnikov-Milne model with respect to 12 kinematic parameters. The second approach developed by us is to find the components of galactocentric centroid's velocity and their partial derivatives with respect to coordinates directly from differential equations for the stellar velocity field. To calculate the kinematic parameters by the methods mentioned above, the same stellar samples were used.

The region of the Galaxy under study occupies the coordinate interval $130° < \theta < 230°$, 3 kpc < R < 13 kpc, -1 kpc < z < 1 kpc. We show the behavior of local kinematic parameters as well as global parameters such as the circular velocity of stars as a function of galactocentric coordinates. For the first time, the components of centroids' spatial velocities and all their partial derivatives as well as their behavior as a function of galactic coordinates have been derived.

The behavior of the $dV_R/d\theta$ and $dV_\theta/d\theta$ parameters as a function of galactic coordinates has been derived for the first time.

CATALOG OF V-MAGNITUDES OF STARS AND GALAXIES FROM DIGITIZED IMAGES OF TAUTENBURG 2-M SCHMIDT TELESCOPE GLASS ARCHIVE

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In 2022, 500 digitized images of epy Tautenburg 2-m Schmidt telescope glass archive were processed and reduced to epy GAIA DR2 reference system. Johnson V color band plates were observed in 1963-1989. Specifications of photographic material have demanded the development of special software, which would take into account its features. Linear dimensions of plates are 24x24 sm with a working field of 3.3x3.3 degrees and a scale of 51.4"/mm (1.03"/px). Astronegatives were digitized with Tautenburg Plate Scanner in five overlapping strips with linear dimensions of 5400x23800 px. The software developed in MAO NAS of Ukraine for the image processing of these scans takes into account the horizontal overlap and the vertical offset of strips. Image processing results in the catalog of positions and V-magnitudes of 2 673 686 objects down to $V \leq 20^m$ at the epoque of 1974.5. Positions of stars and galaxies were reduced to the GAIA DR2 reference system, and magnitudes were obtained in the Johnson V color band. The internal positional accuracy of the catalog for all objects is $\sigma_{\alpha\delta} = \pm 0.14$" and the photometric one is $\sigma_V = \pm 0.12^m$. The comparison of the V-magnitudes of the resulted catalog with the G-magnitudes of GAIA DR2 common objects was carried out.

VARIABILITY OF THE INTERMEDIATE POLAR RX J2133.7+5107

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We report the results of long-term time series photometry on RX J2133.7+5107. Using data taken during 2007-2022 (15 yr), we confirmed and improved the results obtained by de Miguel et al. (2017). Due to longer time-base we obtained more accurate value of the spin-up time-scale 1.511(3)*10^5 yr. The observed rate of spin-up is even faster then reported by de Miguel et al. (2017) and one of the fastest of all known intermediate polars. We confirm the presence of superhumps and studied the changes of superhump period. Also we report a presence of complicated changes of (O-C) with a period of about 7 years, that may be interpreted either as fluctuations around the equilibrium period or as a presence of a third body orbiting the inner close binary system.

ON MAGNETIC FIELD OF THE HOT EVOLVED STAR HR 3042

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We present the preliminary result of magnetic field study on the hot evolved star HR 3042 (B8/9 II). The study is based on the spectropolarimetric observation with the 3.6m CFHT ESPADONS obtained from the open database CADC. From observation during 1 night in 2016, HR 3042 was reported to have the magnetic field which longitudinal component reach of about -230 G. In 2017 and 2018, the star was observed for 15 nights, but the results of these observations were not published.

We treated all the data and confirmed that the star has the magnetic field with the longitudinal component of about several hundred Gauss. By performing the Fourier analysis of the magnetic time series, we have first established the rotation period of the star, which is about 4 days. We also simulated the magnetic field of HR 3042 under the assumption of an oblique rotator model. The results of the study will be presented in our talk.

DETECTION OF SPIRAL STRUCTURES OF THE MILKY WAY GALAXY USING KINEMATIC ANALYSIS

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The nature of the formation of the spiral structure of our Galaxy is still not unambiguously determined. The main problem in the study of the spiral structure of the Galaxy is the difficulty in determining the trigonometric parallaxes of stars and their significant errors, as well as the limited number of samples of the studied objects. The third data release of the Gaia space mission provided highly accurate data – positions, proper motions, parallaxes and radial velocities for more than 33 million stars of various types. In the presented study, we analyzed the data of red giant and subgiant stars, which made it possible to cover and analyze in more detail the structural features of a significant part of the Galaxy. The area under study covered a part of the Galaxy with Galactocentric coordinates within $115^\circ < \theta < 245^\circ$, 0 kpc < R < 16 kpc, -1 kpc < z < 1 kpc. A detailed analysis was made of the diagonal components of the velocity deformation tensor M+11, M+22, M+33, which characterize the compression or extension of the studied stellar systems along the x, y, and z axes in the rectangular galactocentric coordinate system, as well as their relationship with structural features and the behavior of the spiral arms of the Galaxy.

THE POSITRON Γ-SPECTROSCOPY OF SYMBIOTIC SYSTEMS

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For AM Her types cataclysmic systems in soft γ-ray spectra we calculated annihilation lines who indicates p-p thermonuclear explosions in surface of the White Dwarfs (WD). We shoved what physical conditions lead to detonation in degenerate plasma can produce positrons. It has been confirmed that the formation annihilation γ-quants with energies of 0.511 MeV is the suitable diagnostic possibility to study the effectiveness of thermonuclear reaction channels during such explosions. It was presented application for registration of annihilation quanta shows that in cases of AM Her type stars. In this systems enter flows of the annihilation γ-quants has upper limit 177 $cm^{-1}sec^{-1}$. The times scale of detonation and γ-flyers are in intervals from 10^{-4} to 10^{-3}sec.

For detection of this events we considered application of new generation of the detectors of hard radiation in base of perovskite crystal. One of them is CsPbBr3 with heavy

mean atomic mass is 65 a.u.m. Under such conditions, it becomes possible to detect γ-flares in a wide energy range. That is, a constructive possibility has applicable to the simultaneous detection of radiation from objects of interest to us practically from optics to the soft γ-range. In practice, the upper energy limit is limited by the physical thickness of the semiconductor crystal. The accuracy of registration of γ-quanta under such conditions makes it possible to construct profiles of γ-lines with an accuracy of 10 KeV and to building detailed spectral line profiles in particular. The using of such detectors requires model measurements and model calculations of γ-rays characteristic fluxes. The main information about p-p detonation located in interval of energies 0.1 – 10 MeV. Positrons generated only in one part of the thermonuclear p-p chain. The time scale of full detonation times is $t_{det} \approx 10^{-3}$ sec.

In WD hydrostatic atmosphere pressure depends from concentration in the relation $P \propto n^{2/3}$. During the accumulation of the heat from thermonuclear p-p reaction in the upper atmosphere, plasma degeneracy is removed faster than in the internal layers of WD who leads to beginning of explosion.

DUAL HARD AND OPTICAL RADIATION DETECTORS FOR FAST NUCLEAR PROCESSES

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The registration and monitoring of rapid nuclear processes in degenerate plasma is a field of our consideration. The flows of hard and optic radiation are considering from outlying astrophysical and atmospheric objects. For of hard radiation and the nature of the nuclear processes, it is showing that the probability of their detection is high. In this case, the detector does not enter in saturation mode. At the other part of this detector located optical matrix and reflection mirror. It is determined that the characteristics of useful signals are considering for the same instrumental function. He detecting it was suggested using of dual semiconductor type detectors. The design advantage of binary detectors is showing. Simultaneous flow measurements allow obtaining high-precision positions and spectral properties of the objects under study. High energies quanta due to the internal photo effect with formation of free electrons and dots in semiconductor detectors. The energy range of hard radiation using semiconductor detectors with consistent of the heavy elements is limited by energies of 0.1 – 10 MeV for γ-rays and 0.1 – 4 eV for optical ones. The current pulse generated by the quanta of these two energy ranges is formed due to the phenomenon of the internal photoelectric effect, which allows electrons to overcome the band gap of the semiconductor. The part of the detector that faces directly at the source of hard radiation consists semiconductor crystal containing atoms of heavy elements. Heavy atoms of the indicated semiconductor interact with the γ-quantum. We presented breadboard installation, where the binary detector is located and carried out a modular experiment with the aim of the subsequent development and manufacture of a new generation of binary detectors that record rare events of a nuclear nature.

PHOTOIONIZATION ANALYSIS OF THE HYDRODYNAMICAL MODELS OF PLANETARY NEBULAE EVOLUTION

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The hydrodynamical simulation results (from Perinotto et al., 2004, A&A, 993-1015) of the Planetary Nebulae evolution were used to calculate the photoionization models grid of these objects. On the base of the obtained modelling ionic abundances as well as chemical compositions assumed in models were used to derive the corresponding Ionization Correction Factors (ICFs). The new ICFs as well as the observed emission line spectra (from Henry et al. 2010, ApJ, 724, 748) of PNe in Milky Way galaxy were used for diagnostic of the physical conditions and chemical abundances in their envelopes. Using these results as well as distances to these PNe the gradients of distribution of chemical elements in the Galaxy were obtained. Also the photoionization models spectra as well as chemical compositions assumed in models were used to estimate the reliability of the popular ICFs (implemented in diagnostic code PyNeb) proposed by other authors.

IONIZATION-CORRECTION FACTORS OBTAINED BY PHOTOIONIZATION MODELING OF HII REGIONS SURROUNDING CONTINUOUS STAR-FORMING REGIONS

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Multicomponent photoionization modeling of low-metalicity H II regions around areas of continuous star-forming regions was obtained, in particular, synthetic fluxes of strong forbidden lines and ionic abundances of chemical elements. We select the best models whose relative intensities best reproduce the corresponding observed relative intensities. The ionic abundances of chemical elements obtained in the selected models were used to obtain ionization-correction factors (ICF). With the help of ICF, it is possible to further determine the relative chemical abundances of elements and redetermine the abundance of primordial helium and the rate of its enrichment during stellar chemical evolution of matter, as was done for low-metalicity H II regions around starburst regions.

COMPARATIVE ANALYSIS OF OBSERVATION OF THE SELECTED EXOPLANETS TRANSITS OBTAINED AT THE KYIV COMET STATION, WITH THE LIGHT CURVES OF THEIR PARENT STARS, FROM THE TESS AND THE KEPLER SPACE TELESCOPE DATABASE

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We present a comparative analysis of observation of the selected exoplanets transits obtained at the Kyiv Comet Station, with the light curves of their parent stars, from the TESS (Transiting Exoplanet Survey Satellite) and Kepler space telescope database. The light curves obtained by the TESS and Kepler orbital telescopes were processed using a program developed based on the Python package Lightkurve 2.3 is freely available in the MUST archive (Barbara A. Mikulski Archive for Space Telescopes). Observations were also carried out on the 70-cm reflecting telescope AZT-8 (Lisnyky). Photometric processing of the observation results was performed by using the Muniwin program. The light curves and parameters evaluation of observed transits and the exoplanet's orbital parameters obtained from ground observations were published in the ETD (Exoplanet Transit Database). Defined transit parameters were compared with the results of the TESS command, which are stored in the MUST archive. The research paper presents a comparison of the parameters of transit phenomena (period, depth, transit duration), and selected exoplanets orbital parameters obtained from two independent sets of observations, terrestrial and orbital, performed in different epoch.

REFINED PHYSICAL PROPERTIES OF THE HD 327083 BINARY SYSTEM

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HD 327083 is a member of a small group of supergiants exhibiting the B[e] phenomenon. It was found to be a binary system with an early-B and an early-F supergiant components. However the fundamental and orbital parameters of the system were not accurately known. We determined a new set of the system parameters that include the orbital period and the components' masses using a combination of photometric and spectroscopic data. A new orbital period of 107.7 days was found from both the spectral line positional variations and the visual light curve. Absorption lines of the cool component show radial velocity semi-amplitude of 48.3 km s^{-1}, similar to that of emission lines that originate around the hot component. The system shows partial eclipses. We estimated the components' masses to be nearly equal and close to 6−8$M_\odot$. The masses turned out to be smaller then the evolutionary masses that may be a consequence of a recent mass-transfer.

PERIOD CHANGES OF V965 CEPHEI: A SIGN OF THE BINARY SYSTEM?

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The period change for the HADS star V965 Cep was found previously by the author from the O-C diagram built using observations in the V-band only (https://app.aavso.org/jaavso/article/3707/). In the current work, the O-C diagram was supplemented by the data from non-filtered observations taken from literature sources, the AAVSO database, and the author's observations. The joined O-C diagram covers the period from 2010 to 2022. The most recent data shows the deviation from the parabolic trend; this may suggest that period changes may be due to the light-time effect, i.e., the star may be a part of a binary system.

SPECTRAL OBSERVATIONS OF THE HERBIG BE STAR HD 53367

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The unusual spectroscopic behavior of star Herbig Be HD53367 is described based on the spectra obtained on the Cassegrain focus of the 2-meter telescope at the Shamakhy Astrophysical Observatory, using the Fiber Echelle Spectrograph (ShAFES), with a spectral resolution of R=28000.The results of comparative behavior analysis of profiles of selected lines (Hα, Hβ, HeI λ5876 Å, NaID, H and K CaII) are presented with analogical data published in the literature.

FUNDAMENTAL PARAMETERS OF A SPECTRAL CLASS GIANTS STARS

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The atmospheres of HD203925(A8III), and HD95382(A5III) giant stars of the A spectral class were studied using the model and parallax methods. The effective temperatures T_{eff} and surface of gravity g of stars were determined based on a comparison of the observed and theoretically calculated values of the photometric quantities $[c_1]$, β, Q, and the equivalent widths of the spectral lines of the hydrogen Balmer series and the using of parallax. Based on the FeII lines the microturbulence ξ_t and the metallicity [Fe/H] were determined. In the atmospheres of the stars, the metallicity is close to the metallicity in the Sun. This shows that the stars we studied and the Sun are formed from the same metallicity matter. This result is important from the point of view of the chemical evolution theory of the stars.

PHOTOMETRY REDSHIFT RECONSTRUCTION USING MACHINE LEARNING TECNICUE FOR THE SDSS GALAXIES AT 0.2 < Z < 1.0

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We consider a data-driven approach as an alternative to the traditional photometric techniques to determine distance moduli to the galaxies. We focus our attention on galaxies at 0.2 < z < 1.0 from SDSS DR14. We came up with a technique based on the machine-learning regression for computing redshifts for moderately distant galaxies. We used key observable parameters such as the corrected Petrosian fluxes, Petrosian radii, inverse concentration index R50/R90 in griz-bands, color indices g-r, g-i, g-z, and celestial coordinates as input explanatory variables for training, and redshift as the target parameter. We exploited the five machine learning regressions to predict redshifts: Linear, Polynomial, K-Nearest Neighbors, Gradient boosting, and Artificial Neural Network (ANN). As the main dataset, we selected 464,208 galaxies from the SDSS DR14 with spectroscopic redshifts. We found that usage of the ANN regression model with two hidden layers is the most effective. The obtained mean rms error for the calculated redshifts is equal to 0.046 for whole test dataset. Relative errors: ΔdL/dL =10-22% with rms error σ(Δz_norm) = 0.032 at 0.2 < z < 0.8 and ΔdL/dL =30-60% with rms error σ(Δz_norm) = 0.172 at 0.8 < z < 1.0. The proposed ANN regression model is complementary to the existing photometric redshift reconstruction. The attaining moduli distance error Δm = 0.28 mag for galaxies at 0.2 < z < 0.8 is comparable with secondary distance indicators and machine learning methods.

RADIOACTIVE ELEMENTS IN STELLAR ATMOSPHERES OF CEPHEIDS. ACTINIUM.

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The first studies of the absorption lines of actinium in the spectra of certain stars showed that the appearance of actinium in their spectrum is associated with the presence of deformation of strong lines, in some cases with emission components. To search for absorption lines of actinium in the spectra of stars we attracted attention to such class of stars as Cepheids, which are characterized by deformation of strong lines due to pulsations. Remember, that actinium is radioactive element, which has an isotope 227Ac with the longest half-live of 21.772(3) years and atomic number 89.

SOLAR SYSTEM AND SPACE ENVIRONMENT

CLOSE ENCOUNTERS OF STARS ACCORDING TO THE GAIA EDR3 CATALOG

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Comets move in the Oort cloud at the edge of the Sun's gravitational field. At heliocentric distances greater than 50,000 AU, comets experience significant tidal disturbances from the center of the Galaxy and gravitational disturbances from nearby stars. Stars which pass close to the Sun can perturb the Oort cloud, injecting comets into the inner solar system where they may collide with the Earth.

We used the third release of the Gaia data, Gaia EDR3, encompasses astrometry and photometry, complemented with radial velocities stars. A numerical model of the motion of stars in the Galaxy is proposed to search for close encounters with the solar system.

THE DATABASE OF METEOR BODIES ACCORDING TO OBSERVATIONS IN 2019-2021 WITH THE AUTOMATIC VIDEO AND SPECTRAL METEOR PATROL OF V.N. KARAZIN KHARKIV NATIONAL UNIVERSITY

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The database of positional and spectral observations of meteors in 2019-2021 using the automatic video and spectral meteor patrol of the Institute of Astronomy of V.N.Karazin Kharkiv National University has analyzed.

The kinematic parameters, elements of the heliocentric orbits of meteoroids and their masses were calculated using the methods of meteor astronomy.

The software for meteor spectra analysis has been created. The work is aimed at the procedure of the spectral video observations processing. The data from the NIST electronic database (https://physics.nist.gov/PhysRefData/ASD/lines_form.html) is used for obtaining the composition of chemical elements in the meteoroid. The software allows to generate synthetic spectra and compare them with observed meteor spectra. As a result, we obtain information about the relative quantitative chemical composition of meteoroids and the physical conditions of meteor plasma formation.

OBSERVATION OF AN OCCULTATION OF THE UCAC4 488-082551 STAR BY ASTEROID (76228) 2000 EH 75

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Observations of an occultation of the UCAC4 488-082551 star by asteroid (76228) 2000 EH 75 were carried out on 31 May 2022 at the Kryzhanivka observation station of Odesa I.I. Mechnikov National University (the observatory code A85). A set of instruments which included a Schmidt telescope (the primary mirror diameter D = 271.25 mm; the corrector plate diameter D_k = 223.9 mm; the focal length F = 440 mm), a GPS receiver and Videoscan-415-2001 CCD camera, was used to perform observations. The observing conditions were as follows: clear sky, the star's altitude 49^0 south, the Moon is below the local horizon. The target star from the UCAC4 catalogue (Zacharias *et al*. 2013) has the following photometric parameters: m_B = 14.008; m_V = 12.720; m_r = 12.284; m_i = 11.813. The diameter of the star has not been determined. Asteroid (76228) is a Main Belt asteroid with an orbital period of 4.17178 years. It has an absolute magnitude of 14.93, the visible geometric albedo of 0.123±0.013 and diameter of 5.00±0.23 km (Masiero *et al*. 2011). The time of occultation predicted using ephemerides was 23:52:44±4 sec. The maximum duration of the occultation was 0.4 sec, provided that the observing site was located at the centre of the occultation track (strip). A drop in the star's brightness observed during occultation was about 8^m.

The occultation event was recorded as a sequence of GIF images with the exposure time of 0.5 sec per frame. The system clock of the computer used for the occultation recording was controlled with a GPS receiver in a fashion similar to that described in the paper by Karbovsky *et al*. (2017).

The data processing yielded an estimate of the occultation duration of 0.46±0.04 sec. The uncertainty of the occultation start time within exposure results in the total estimate of accuracy in timing the maximum phase of occultation 23:52:44.06±0.10 sec. The chord length across the asteroid estimated by timing the length of the occultation L = 9.2±0.8. This chord length is close to the estimates of the asteroid diameter reported in the paper by Masiero *et al.* (2011).

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METEORITICAL GROUPS IN CLUSTERS OF NEAR-EARTH ASTEROIDS

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In the current abstract we focus in a explores the possibility of the existence of sporadic fireball groups associated with nine known meteorites for which atmospheric and orbital parameters have been obtained from instrumental observations. The IAU MDC-2007 database [1] as well as other published sources have been used for searching plausible members of these groups. The applied technique of selecting bright meteors and meteorite-dropping fireballs as potential members of a specific group was based on comparison of their individual orbital elements against a known meteorite's reference orbit recognized as asteroidal according to the Tisserand parameter, $T_J > 3.1$ [2]. Two criteria of orbital dissimilarity, namely the Southworth-Hawkins criterion D_{SH} [3] and Drummond criterion D_D [4], were used to make assumption about an associated group of related bodies. The search has detected nine identified groups that contain meteorite-dropping fireballs associated with nine known meteorites.

The orbital clusters among the near-Earth asteroids were found Jopek [5] using a single linkage cluster analysis algorithm and three orbital similarity D-functions. The existence associations of groups of meteorite-dropping meteoroids with near-Earth asteroids (NEAs) is a topical issue with regard to the problem of detecting dynamic and perhaps even genetic relationship between NEAs and groups of meteorite-dropping fireballs. Small asteroids from such clusters can be a potencial parent bodies of meteorite-dropping fireballs. In view of this, we have extensively searched in NEO DyS-2 database [6] of NEAs for those similar to the orbits of nine meteorites. The following threshold values have been set: the Southworth-Hawkins criterion $D_{SH} <= 0.1$, the Drummond criterion $D_D <= 0.05$. The obtained great number of NEAs was then reduced significantly, chose only those with an MOID <= 0.01 au. Such asteroids, according to NASA's definition, are considered potentially hazardous asteroids (PHAs) and the NEAs associated with found groups must be purposefully observed in order to control the date of close approaches to the Earth.

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PHOTOMETRY OF COMET 29P/SCHWASSMANN-WACHMANN 1

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In this work we present the results of processing photometric observations of the comet 29P/Schwassmann–Wachmann 1, which made it possible to estimate the spin rate of the comet's nucleus and to plot the magnitude phase curve. Comet 29P/Schwassmann–Wachmann 1 is a constantly active object belonging to the Jupiter family of comets, moving in a near-circular orbit at a large heliocentric distance of ~6 a.u.. The comet is known for its repeated outbursts.

The data were obtained at the observation station of AO ONU (Odessa-Mayaki observatory, IAU code: 583). The observations were made with two telescopes: RC-600 (19 nights from April 2010 to March 2012) and OMT-800 (12 nights from June 2016 to March 2021). On the dates of observations the phase angle of the comet did not exceed 10 degree. We performed standard photometric reduction with dark and flat-field correction followed by ordinary aperture photometry. Reference stars from the PanSTARRS DR1 catalog were used as photometric standards for the Johnson–Cousins system.

As a result we determined the supposed rotation periods of the comet's nucleus ~14.3 hours and ~22.4 hours. We also obtained a magnitude phase curve where is visible the opposition effect. To obtain a more accurate value of the period, additional long series of observations are required.

DETERMINATION OF SATELLITE ROTATION BASED ON PHOTOMETRY BY A WIDE NETWORK OF OBSERVATORIES

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A many of work has been devoted to the issue of determining the attitude of the resident Space objects (RSO). They consider various approaches to solving the problem – from simply defining illumination conditions

that maximize the differences between the light curves of 3D geometric primitives as a result of their rotation [1] to various methods of the light curve inversion and the use of machine learning methods and neural networks [2, 3, 4]. However, there are not many published works in which these methods are applied to specific RSOs and direct estimates of their rotation parameters are obtained. Previously, we considered the method and fundamental possibility of directly estimating the rotation parameters of RSO, which exhibit specular flashes, based on multisite photometry [5]. The proposed method is aimed at quickly obtaining the angular velocity and direction of rotation of the RSO without any restrictive assumptions about its shape. However, the question is what are the chances of registering a single flash at several observation sites. In this paper, we explore the possibility of using the existing wide network of observatories (on the example of Ukraine) to solve this problem.

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TIME AND GEOLOCATION UNCERTAINTIES AS COMPONENTS OF THE ACCURACY OF NEAS GROUND-BASED OBSERVATIONS

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Statistical analysis of the IAU MPC observational array of the small Solar system bodies and the development of a scheme for assigning weights to individual observations are important for performing asteroid orbit determination and refinement. Errors in the positions of asteroids associated with errors in the reference catalogs, observation epoch, observed brightness and rate of motion are considered in sufficient detail in the works of Chesley et al. (2010), Farnocchia (2015), Veres et al. (2017). Residual differences (O – C) in the equatorial coordinate system are usually used to search and identify functional dependencies. But in the case of observations of NEAs, especially at the moments of close approaches to the Earth, timing errors and errors in the observatory's geolocation can significantly affect the accuracy of the obtained positions. To detect such errors, instead of residual differences (O – C) in equatorial coordinates, it is more convenient to use along-track and cross-track residual differences (O – C) of positions of the observed object. Here we present the simulation results of such errors and analysis using an array of observations from 3 observatories for the period 2017 – 2022. The array contains more than 17,000 positions of about 900 objects, most of which are NEAs, including PHA, and objects during periods of the close approaches to the Earth.

PROCESSING OF ARTIFICIAL SATELLITES PHOTOMETRY OBTAINED BY THE QHY-174M-GPS CAMERA AND SYSTEMATIZATION OF THE DATA

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We presente our attempt to use the QHY174M-GPS camera for the photometry research of artificial objects. This device is useful for imaging occultations, eclipses, meteors, and so on due to a highly precise recording of the time (GPS-based) and location of the observation on every frame and fast readout of the CMOS detector. The precision of time registration by the QHY174M-GPS camera is at the level of microseconds.

All light curves obtained by studied camera during observations of artificial satellites in this work were carried out at Derenivka Observatory of Uzhhorod National University, Ukraine. The created photometric system with QHY174M-GPS camera as the detector and reflector telescope with parameters D=120 mm, F=228 mm, FOV=2.82″x1.76″ was calibrated. For target observations, SharpCap software was used. For the purposes of photometry processing, ccd-phot software was developed using Python 3.8 programming language with astropy and photutils packages. Photometry observations of artificial satellites of the Earth and standard stars were carried out. Over 263 lightcurves of artificial satellites were obtained.

For the storage and data systematization we also develope website that abale user to revise resulting LC. This site contain also observations from our second photometer in Uzhhorod. At this moment we already have collected over 1600 LC in B,V and R filters.

PHOTOMETRIC, POLARIMETRIC, AND SPECTRAL OBSERVATIONS OF COMET C/2014 B1 (SCHWARTZ) WITH PERIHELION DISTANCE 9.56 AU

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We present results of the comprehensive optical observations of the unique disk-like comet C/2014 B1 (Schwartz) with perihelion distance 9.56 au. Quasi-simultaneous long-slit spectra, as well as photometric and polarimetric images with g-sdss and r-sdss filters, were obtained with the 6-m telescope of the Special Astrophysical Observatory on 2017 January 23. The BVR photometric observations of the comet were also obtained at the 2-m telescope of the Peak Terskol Observatory (North Caucasus) on 2017 January 31. We did not reveal any molecular emissions in the spectra. Two nearly linear jets oriented along the position angles of 179°± 1° and 350°± 1° were detected in the coma. Our data demonstrate that the observed disk-like shape of the coma and position of jets remained unchanged, despite the changing observational geometry, for more than 4 years. The most realistic model for explanation of such stable orientation of jets is the existence two active sources located near the north and south poles of the rotating nucleus whose diameter was determined being between 7.6 and 12.2 km depending on the albedo, 0.1 and 0.04, respectively. High activity of the comet is characterized by the high dust production $Af\rho$ which significantly varied, from 4440 to 3357 cm between 2017 January 23 and 31. A significant difference between the radial surface brightness profiles of jets and the ambient (undisturbed by the jets) coma is found. The color of the cometary dust is redder than that of the Sun: on January 23, $V-R = 0.58^{m} \pm 0.05^{m}$, and on January 31, $B-V = 0.85^{m} \pm 0.05^{m}$ and $V-R = 0.54^{m} \pm 0.05^{m}$. The color of the jet structures is much redder than of the ambient coma. Very red color of the nucleus ($V-R = 0.93^{m} \pm 0.19^{m}$) was derived. There are spatial variations of the color and polarization over the coma. The near-nucleus coma is characterized by a low negative degree of polarization (−1% at the phase angle 2.1°) and red color (up to ~ 0.7^{m}), while at the periphery, at about 100000 km, there is a high negative polarization (–6.5%) and a bluer color ($0.6^{m} – 0.45^{m}$). Our modeling showed that the observed trends in color and polarization, as well as the brightness profiles, can be explained by fragmentation of aggregated particles, formed by CO_2/H_2O ices, silicates and organics, which are of radius ~ 1 mm near the nucleus and ~ 10 micron at the periphery.

CHARACTERIZATION OF "HOT POPULATION" OBJECTS IN THE KUIPER BELT

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Most planetesimals formed at distances of 15-30 a.u. were gravitationally ejected from the Solar system as a result of the migration of the giant planets, but a small part remained, captured by Jupiter and the Kuiper belt. As a result, we can now observe such a variety, in terms of physical and dynamical characteristics, in the Trojan asteroids of Jupiter and in the Kuiper belt.

Planetesimals captured by the Kuiper Belt are a "hot population" now. The term "hot" do not refer to the temperature of bodies, but characterize the orbit of objects. ~120,000 objects larger than 100 km. in diameter are known in the "hot population". This population is characterized by an orbital inclination greater than 5 degree and a large eccentricity.

The main task of the work, based on physical and dynamic characteristics, is to search of the same properties Trojan asteroids of Jupiter and objects from the "hot population" of the Kuiper belt, which supposedly migrated earlier from the same region of the original orbit of Neptune. In the work will use data from ground-based observations and space missions.

THE ORBITAL CALCULATION CORE SERVICE AS PART OF AN UKRAINIAN SPACE SURVEILLANCE AND TRACKING SYSTEM

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Space surveillance and tracking (SST) systems are complex. For example, the European space surveillance and tracking system can separate into subsystems: sensory, processing, and services. This work will discuss the features of developing the Ukrainian national processing system in the SST domain.

The processing system in the SST domain is itself complex. In it, separated components can be distinguished, such as:

- observational information storage,
- the value and quality analysis of observations,
- orbit determination and propagation,
- storage of orbital elements and satellite position ephemeris,
- orbital information analysis,
- etc.

The development of the whole processing system in the SST domain requires the involvement of a lot of human and material resources. Many components of the processing system have independent values. Their development can produce using a less team with fewer material costs. Thus, we come to the idea of developing the entire processing system in the form of independent and consistent development of autonomous components. One of the architectural approaches that satisfy this task is microservice architecture.

This work describes our general architectural approach to making the processing system as a set of autonomous microservices. An important part of our approach is the voluntary and independent participation of microservices developers in the making processing system. As part of this approach, we present a microservice for basic orbital calculations. At this milestone, the orbital calculation core service already provides services for orbit propagation of artificial satellites, the quality analysis of optical measurements of equatorial coordinates, and some other auxiliary services in test mode.

KHARKIV DATABASE OF ASTEROID ABSOLUTE MAGNITUDES

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We present a database of the absolute magnitudes of asteroids named the Kharkiv Asteroid Absolute Magnitude Database (KhAAMD). The database includes a homogeneous set of the absolute magnitudes for about 400 asteroids in the new *HG*1*G*2 magnitude system. We performed a comparative analysis of the asteroid absolute magnitudes between the Kharkiv database and other main magnitude databases (MPC, Pan-STARRS, ATLAS, PTF, and Gaia). We show that the PanSTARRS absolute magnitude dataset has no systematic deviations and is the most suitable for the determination of diameters or albedos of asteroids. For the MPC dataset, there is a linear trend to overestimate the absolute magnitudes of bright objects and underestimate the magnitudes of faint asteroids. The ATLAS dataset has both a systematic overestimation of asteroid magnitudes and a linear trend. We propose the equations, which can be used to correct for systematic errors in the MPC and the ATLAS magnitude datasets. There are possible systematic deviations of about 0.1 mag for Gaia and PTF databases but we have insufficient data overlapping with our data for a definitive analysis.

MONITORING OBSERVATIONS OF COMET 29P/SCHWASSMANN–WACHMANN 1 DURING 2012-2019

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We present the results of photometrical observations of comet 29P/Schwassmann-Wachmann 1 for 17 nights from 2012 to 2019 at the Lisnyky observational station of Taras Shevchenko National University of Kyiv. Apparent magnitudes and dust productivity level in filter R were calculated. Middle and height dust activity of the comet is characterized by Afρ proxy which varied from 1246 to 17563 cm during all periods of observation. Based on the morphological analysis, we detected four jet-like structures in the coma on almost all dates. Using the geometrical model for the jet structure interpretation during all observation sets, we obtained following results: the nucleus rotation period of 57±2 days, the rotational axis orientation, the locations of active regions for four jet-like structures within a narrow belt near the equator.

M-TYPE DOMINATED MAIN BELT ASTEROID FAMILIES

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In the entire terrestrial collection of meteorites, irons compose less than 5%, but at the same time they represent one of the most heterogeneous groups of meteorites in terms of isotopic compositions.The vast majority of iron meteorites belong to only 4 groups, each of which presumably comes from a single parent body. We can expect the presence of at least several families of metallic asteroids formed as a result of catastrophic collisions with the ejection of numerous fragments. Such collisions with numerous fragments should have led to the formation of asteroid families. As it is assumed that the iron meteorite parent bodies can exist among M-type asteroids, we searched for families containing M-type asteroids. The main goal of our analysis was to search for M-type dominated asteroid families. We have analyzed all known asteroid families with more than 100 members according to the Nesvorny database together with their albedos and colors based on the latest version of the WISE catalogue and the new catalog of asteroid brightness measurements, obtained based on the processing of all available SDSS images. Results of our analysis will be presented and discussed.

The work was supported by the National Research Foundation of Ukraine (grant N 2020.02/0371 "Metallic asteroids: search for parent bodies of iron meteorites, sources of extraterrestrial resources").

A PHOTOMETRIC METHOD FOR DETECTING DEGRADATION IN THE SATELLITE SURFACE OPTICAL PROPERTIES

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This paper describes a method for employing photometric data to estimate degradation in the reflectance properties of the satellite surface material under conditions of its long stay in space. It also presents the procedure of ground-based multicolour BVR photometric observations of several geostationary satellites built on different types of buses and the results obtained over a period from 3 to 9 years. These are geostationary satellites Astra 2E (on the Eurostar 3000 bus), Azerspace-2/Intelsat 38 (on the SSL-1300 bus), Sicral 2 (on the Spacebus-4000B2 platform) and Blagovest 11L (the Ekspress-2000 bus).It has been revealed that a pattern of change in the reflectivity of different geostationary satellites is dissimilar. Spacecraft materials used for the surfaces of geostationary satellites manufactured in the second decade of the 21st century are more resistant to the harshspace environment than those used for the satellites built in the late 20th century. We have proposed several ways of improving the method for identifying the spacecraft material type based on multicolour photometric observations. The method presented here can be adopted as additional or complementary to the laboratory techniques for detecting the spacecraft surface degradation.

ON THE POSSIBILITY OF DETERMINING THE SATELLITE'S EXTERNAL PAYLOAD FROM LIGHT CURVES

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The external payload of the satellite is structurally placed on the platform.

Based on the analysis of the light curves of several geostationary satellites, the possibility of determining an external payload in a number of cases is shown.

REMOTE SENSING OF LUNAR SPINEL DEPOSITS ON THE ARITARCHUS CRATER AND THE COBRA HEAD USING M3 SPECTRAL DATA

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We developed the new approach for the remote identification and mapping of spinel deposits on the lunar surface using spectral data. The idealized chemical formula of spinels is AB_2O_4, where the cations A^{2+} and B^{3+} are typically represented by Mg, Al, Fe, Ti and Cr. These minerals usually form only accessory component (less than 10 wt.%) in the mineral composition of the lunar regolith. However, the analysis of their occurrence and distribution is important for further developments of views on the composition of lunar interiors and geological processes leading the deep material excavation.

Our approach bases on the general spectral behavior of spinels in the Vis-NIR range of wavelengths. They have almost featureless spectra from 500 to 1550 nm with the deep wide absorption band starting at 1550 nm. We used in the analysis the correlation of color ratios A(950 nm)/A(750 nm) vs. A(2650 nm)/A(1550 nm). The first parameter characterizes the strength of the ferrous absorption band near 1000 nm, while the second one describes the absorption near 2650 nm. The combination of these color indexes is unique for the spinels' presence in the mineralogical composition of the lunar regolith. We applied this technique to investigate spinel deposits in the Aristarchus crater and the Cobra Head formation using the hyperspectral data of M3 scanning spectrometer onboard Chandrayyan-1 spacecraft. We identified three main spinel-bearing units in these locations: the central peaks of the crater, subsidiary deposits on the crater floor and walls, and the deposits on the southern wall of the Cobra Head 50 km away from the crater. Using the high-resolution data, we have shown that spinel deposits are generally associated with massive boulder fields and higher albedo areas. The geological context and possible mechanisms of spinel surface occurrence have been discussed.

DART: DOUBLE ASTEROID REDIRECTION TEST – OBSERVATION CAMPAIGN

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Asteroid impact avoidance is one of the important issues of our time, it is important to develop methods for protecting the Earth from space bodies. One option is to change the orbital trajectory small body of the Solar system. DART: Double Asteroid Redirection Test – the first test to change the orbit of a space body as a result of a

collision with an artificial body. DART IMPACT will be September 26, 2022, 7:14 p.m. EDT. On this date, the LICIACube module from the DART satellite will collide with the natural satellite Dimorphos from the binary system (65803) Didymos.

We are organizing an observation company for the asteroid (65803) Didymos. It is planned to determine the orbital period of the Dimorphos satellite before and after the collision, to clarify the spin rate of the central body of the binary system (65803) Didymos. Using archival data, we plan to check the presence of the BYORP effect in this system.

PHASE DEPENDENCE OF ALBEDO OF LUNAR IRREGULAR MARE PATCH INA OBTAINED FROM LROC NAC DATA

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One of the interesting Lunar geological formations is Irregular Mare Patches (IMPs). Now, there are dozens of similar features in the lunar maria [1], considered as IMPs. *Ina* is the most prominent representative of this kind. Because of the unusual and complex characteristics of IMPs, their specific mechanism of formation is being discussed.

New additional information for understanding the mechanisms of formation of Ina and other IMPs has been provided with our photometric studies. Our new approach to photometric correction of LROC NAC data based on multi-phase photoclinometry allows one to obtain high-quality phase dependence of albedo in wide range of phase angle.

We obtained phase dependence [2, 3, 4] of albedo for the selected region of *Ina* in the range of phase angles 5.7°..89.3°. All used images have been co-registered, combined and corrected for the geometric and photometric influence of topography using the technique described in [5, 6] applying the high resolution DEM obtained by us.

Both the obtained phase dependencies and phase ratios of albedo show significant differences in the optical (photometric) properties of the regolith in "blocky" areas of the Ina formation in comparison with surrounding areas, which indicates their different nature of formation. The same effect can be observed for the halos of lunar craters [7]. We observe the following sequence of gradual decrease in sub-resolution surface roughness: blocky areas > regular mare > INA mounds > INA hummocky units.

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PHOTOMETRY OF COMETS C/2013 V2 (BORISOV) AND C/2017 T2 (PANSTARRS)

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We present our preliminary results of searching for short-term dust color variations of long-period comets C/2013 V2 (Borisov) and C/2017 T2 (PanSTARRS). Observations of the comets were taken at the Skalnaté Pleso observatory (IAU Code – 056) using the 0.61- and 1.3-m telescopes. Both comets have demonstrated mostly red photometric color of their dust coma, but, also, we have detected variations to blue or neutral color during a few days. The observed dust productivity of the comet C/2017 T2 (PanSTARRS) is quite high. Dust production respects to measurements of long-period comets at the similar heliocentric distances. On contrary, C/2013 V2 (Borisov) has faint brightness and low dust productivity. Further, we are going to study dust coma morphology of these comets. Finally, the results of our photometry both comets can be used for modelling of chemical composition of these dust comae.

UNIDENTIFIED AERIAL PHENOMENA I. OBSERVATIONS OF EVENTS

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The Pentagon has taken up UFO research as part of the All-domain Anomaly Resolution Office (AARO) project. The mission of the AARO will be to synchronise the efforts of the Department of Defense and other federal departments and agencies of the United States to detect, identify and attribute unidentified anomalous, air, and space objects. NASA is also commissioning a research team to study Unidentified Arial Phenomena (UAP). We are also getting involved in UFO research. According to our data, there are two types of Unidentified Aerial Phenomena, which we conventionally call: (1) Cosmics (COS), and (2) Phantoms (PHA). These are daytime phenomena observed in clear skies. We note that Cosmics are luminous objects, brighter than the background of the sky. Phantoms are dark objects, with a contrast, according to our data, from 50% to several per cent. Both types of UAPs exhibit extremely high movement speeds. Their detection is a difficult experimental problem. They are a by-product of our main astronomical work, daytime observations of meteors and space intrusions. We conducted a series of two-site observations of UAPs and found and evaluated the optical and colourimetric characteristics of the objects. Single and group objects of different brightness, different sizes, and moving at different speeds from 3 to 13 angular degrees per second were found.

SOLAR ACTIVITY, SOLAR-TERRESTRIAL RELATIONS, ASTROBIOLOGY

SOLAR CYCLE 25 FORECAST: AVERAGE CYCLE WITHOUT SIGNS OF MAUNDER-LIKE SECULAR MINIMUM

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On a base of data for 24 previous cycles of solar activity, statistical connection was considered between sunspot number on grown phase of solar cycle (from 21 to 30 months of cycle) and its amplitude. It was concluded, that amplitude of 25th cycle should be $W_{max}(25) \approx 180$ units in case when whole grown phase of cycle will be monotonous and $W_{max}(25) \approx 120$, if grown phase will non-monotonous, with splitted top similar to 24th cycle. In other words, our prediction can be written as $W_{max}(25) = 150 \pm 30$ that corresponds to a moderate cycle, in good accordance with Gnevyshev-Ohl rule. Taking into account such parameters of current 25th cycle, we can conclude that no evidences are in present about deep Maunder-like coming minimum of solar activity in secular cycle in middle part of 21st century. We plan to discuss also some other features of the current 25th cycle.

RESULTS OF OBSERVATIONS OF WAVE MOTIONS IN THE SOLAR FACULA

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The results of spectropolarimetric and filter observations of the facular region in the lines Fe I 1564.3, Fe I 1565.8 nm, Ba II 455.4 nm, and Ca II H 396.8 nm obtained near the center of the solar disk at the German Vacuum Tower Telescope (Tenerife, Spain) are discussed. It is shown that the facular contrast at the center of the Ca II H line increases more slowly as the magnetic field strength increases and, then it begins to decrease if the field increases further. It is concluded that the reason for such behavior is the nonlinear height dependence of the line source function due to the deviation from the local thermodynamic equilibrium. It is found that waves propagating both upward and downward can be observed in any area of the facula, regardless of its brightness. In bright areas with a strong magnetic field, upward waves predominate, while downward waves are more often observed in less bright areas with a weak field. It is shown that the facular contrast measured at the center of the Ca II H line correlates with the power of wave velocity oscillations. In bright areas, it increases with the power regardless of the direction in which the waves propagate. In facular regions with decreased brightness, the opposite dependence is observed for both types of waves. In turn, the power of wave velocity oscillations is sensitive to the field strength magnitude. In the magnetic elements of the facula with increased brightness, the stronger the field, the higher the power of oscillations of both upward and downward waves. In areas with decreased brightness, the inverse dependence is observed. It is concluded that the contrast increase with the increase in the power of wave velocity oscillations observed in bright areas of the facula can be considered as evidence that these areas look bright not only because of the Wilson depression but also because of the heating of the solar plasma by the waves.

TIME DYNAMICS OF BACKGROUND LUMINESCENCE SPECTRA OF HOTOBACTERIUM PHOSPHOREUM

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The intensity of bacterial luminescence depends on many factors but one of the strange phenomena is the correlation of the bacterial glow with the dynamics of cosmo-geophysical processes associated with space weather, in particular with variations of the natural electromagnetic background [1]. In previous studies, we revealed the coincidence of periods of the luminescence of Photobacterium phosphoreum and the physical-chemical properties of water, as well as their correspondence to the dynamics of space weather factors [2]. The purpose of this study was to find out the possible mechanisms of connection between these processes based on the analysis of the luminescence spectra of photobacteria.

We observed the bacterial luminescence in range from 240 to 700 nm with a dominant maximum at 460-500 nm which corresponded to the luminescence of FMN-containing proteins. It is known that the excitation of the electronic structure of FMN requires an energy of about 3 eV, which corresponds to the energy of light waves with a length of 412 nm. But we observed the bacterial suspensions also glow in the UV region of the spectrum that testify to much more energy generated in the enzymatic process of oxidation, which should exceed 5 eV. This fact allows us to assume the involvement in this process of active forms of oxygen, such as OH* and HOO* radicals, the recombination of which is accompanied by the emission of light quanta in the UV range. The generation of UV light in bacteria explains the nature of small local maxima in the bioluminescence

spectra associated with the induced fluorescence of aromatic amino acids - 270-290 nm (phenylalanine), 302-310 nm (tyrosine), 320-350 nm (tryptophan). At the same time, local maxima in the green, yellow, and red regions of the spectrum may be associated with the presence of other fluorophores, in particular fluorescent proteins LumP, etc. The analysis of the time variability of the background luminescence spectra of P. phosphoreum photobacteria in 240-700 nm showed the existence of periodic components of 20-25 min that are very close to the period of 18-19 min of collective spin ortho-para transitions in water molecules [3]. Such transitions can be sensitive to the influence of electromagnetic fields in wide frequency and amplitude ranges and are associated with changes in space weather, which requires additional study.

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LONG-TERM MONITORING OF THE QUIET SUN

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The monitoring program of long-term variation of selected solar spectral lines is described. The aim of the program is to study how the physical parameters of the quiet solar atmosphere change over the 11-year cycle of solar activity. The research is based on high spectral resolution observations of the quiet Sun using the Ernest Gurtovenko horizontal solar telescope of the Main Astronomical Observatory of the National Academy of Sciences of Ukraine. Such measurements are possible due to the high metrological stability of the instrument. Since 2012 the observations are performed daily, when the weather conditions allow. We found that the line core depths and full widths at half maximum of the Fe I solar spectral lines correlate with the cycle modulation of the total unsigned magnetic field and the Wolf numbers of the Sun. The behaviour of these line parameters can be explained by variations of the temperature and convective motions of the quiet photosphere during the 11-year cycle.

THE PHENOMENON OF REGIONAL SPACE WEATHER EFFECTS IN LATVIA AND UKRAINE – PERSPECTIVE PRACTICAL APPLICATIONS

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The project proposes the application of an original research complex to determine the regional impact of the state of space weather, identify features during periods of magnetic storms of various types and create a basis for practical applications. Such regional projects have not been carried out before. The complex includes the most modern radio telescopes VIRAC (Latvia) (RT-32, RT-16, LOFAR-LATVIA) providing an opportunity to study the state of the cosmic environment in the range from centimeter to decameter wavelengths. Radio-telescope "URAN-4" of the IRA NASU (Ukraine) leads an unprecedented multi-year program of "enlightenment" of the ionosphere by the removal of powerful cosmic radio sources in a decameter range in the Odessa magnetic anomaly zone.An essential component of this complex is continuous regional monitoring of the geomagnetic field using magnetometers from the Institute of Geophysics of the National Academy of Sciences of Ukraine, which provide interesting results in the areas of regular and anomalous magnetic fields. As a result of the project, the basis will be created for the creation of a space environment monitoring system in Latvia based on the experience of research in Ukraine and the acquisition of joint unique observational material of the period of increased solar activity for practical applications.

SOLAR AND GEOMAGNETIC ACTIVITY SPECIFICS IN ODESSA MAGNETIC ANOMALY ZONE – FIRST RESULTS MAGNETOMETRIC OBSERVATIONS

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The results of joint studies of flux monitoring of bright space radio sources on radio telescope "URAN-4" RI

NASU and geomagnetic variations on magnetometer of Institute of Geophysics NASU in the zone of Odessa magnetic anomaly are presented. Radio sources scintillations reflect perturbations in the ionosphere occurring during periods of solar and geomagnetic activity, as well as manifestations of regular seasonal and diurnal phenomena, thermal and gravitational tides. Magnetometric observations with a temporal resolution of 1 second allow us to identify by means of wavelet analysis the spectrum of short-term variations occurring during radiation and magnetic storms at different phases of their manifestation. There is a significant difference in the manifestation of short-term variations in magnetic storms with sudden and gradual onset. The observational cycle was conducted in the period from 2017 to 2022 and covers the decline phase of 24 and the rise phase of 25 solar cycles. Test observations were made on the LOFAR-LATVIA radio telescope (VIRAC) to observe scintillations of bright radio sources in a wider frequency range than on the RT «URAN-4».

INDICATIONS OF SUPERSTRONG MAGNETIC FIELDS IN A LIMB SOLARE FLARE AND AN ACTIVE PROMINENCE FROM SPECTRO-POLARIMETRIC OBSERVATIONS IN Hα AND D3 LINES

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We present the indications of super-strong magnetic fields of 10^5 Gauss range in the 14 July 2005 limb solar flare. Such strong fields are found at altitudes of 10–20 Mm during the post-peak phase of the flare and are manifested as highly split peaks (up to 4 Å apart in wavelength) in the far wings of the Hα emission. The study of the Stokes V profiles shows the presence of a significant circular polarization which is antisymmetric with respect to the center of the broad emission. The shape of the Stokes V profiles significantly differs from the dI/dλ intensity gradient profiles which indicates the strong magnetic field regime. Similar spectral phenomena were also observed for a prominence of 12 July 2004 at heights of up to 25 Mm in the He I D3 line. If these spectral features are interpreted as manifestations of the Zeeman effect, the corresponding magnetic field strengths reach up to ~130 kG.

It should be noted that such spectral phenomena are very rare and are not present in the spectra of most flares and prominences, which we illustrate by performing similar analysis for an active prominence of 24 July 1999.

In order to investigate the possibility of interpretation of such highly split spectral features as the manifestation of magnetic fields of extremely high magnitudes we performed a theoretical study of the dependency of the line profiles on the magnetic fields of various strength. The calculations show that the fine structure of the spectral lines at such extremely high magnetic fields results in the profile shapes similar to the observed ones, which suggests that the observed patterns in the Stokes V profiles can indeed be a manifestation of extremely strong magnetic fields.

RADIOASTRONOMY

FAINT RADIO EMISSION FROM STRONGLY LENSED QUASARS

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We study the sample of 11 gravitationally lensed quasars in the redshift range 0.802 – 3.36. Our study complements available radio surveys by targeting gravitational lenses because it allows us to detect the faintest otherwise not-detectable sources. For our sample, we use the observations from the Hubble Space Telescope (HST) in 3 optical/near-IR filters (F475X, F814W, F160W) and Karl G. Jansky Very Large Array (VLA) at 3 GHz. Our radio shows 5 resolved and 2 unresolved detections, and 4 non-detections. We find that the weak radio emission is most-likely SF-driven for 3 targets, AGN-driven for 2 targets, and a mixture of both for the rest of the detected sources. These results agree with some of the previous results from the optically- and infrared-selected strongly lensed and unlensed quasar samples. However, they also indicate for the need of future high-resolution long-baseline radio observations to disentangle the processes at play.

WEB PAGE OF THE RADIO ASTRONOMY RESEARCH LABORATORY NAMED B.L. KASHCHEYEV: PROJECT OF THE SCIENTIFIC AND INFORMATIONAL COMPONENT

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The site is an information center needed to highlight scientific developments and attract new scientific projects.

The relevance lies in the fact that in the modern conditions of radio astronomy in Kharkiv, development and cooperation with international colleagues is needed.

Site for Radio Astronomy Research Laboratory Named B.L. Kashcheyev Of Research Department will contain information pages covering scientific developments, software components for calculating meteor orbits, as well as modern news from the world of astronomy.

RADIO TECHNOLOGIES IN METEOR ORBITAL RADARS OF THE 20TH AND 21ST CENTURIES: ADVANCES AND DEVELOPMENTS

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Meteor orbital radars are ground-based radar systems that have the function of measuring the orbits of meteoroids. Determining orbits is considered a more complex scientific experiment than registering the number of incoming meteoroids. This will be an active method for studying meteoroid intrusions into the Earth's atmosphere at altitudes close to 90 km, when the radar system is equipped with a transmitter emitting in the meter range. We talk about the specular meteor radars (SMRs).

The well-known radar systems of the 20th century will be considered: the Harvard Radio Meteor Project Radar in the United States, the Ukrainian Meteor Automatic Radar System - "MARS" and the New Zealand Meteor Orbital Radar -"AMOR". In the 21st century, new opportunities have appeared associated with the development of radio electronics and the IT industry. All-sky meteor systems “SKiYMET meteor systems” have become widespread, and not so long ago another modification of them, ComMet/21i ("ComMet" in short-hand) appeared. Two meteor orbital radars using SKiYMET technology operate in Canada - "CMOR" and Argentina - "SAAMER". They register meteoroid orbits, the survey of which is used to build a model of the meteoroid environment of the National Aerospace Agency of USA - NASA.

Comparison of technologies is carried out. Together with others, the issues of taking into account the selectivity of observations in different systems are discussed. Processing of radio meteor information is also included in the field of consideration.

INITIAL RESULTS AND PARAMETERS OF THE FIRST DECAMETRE CENSUS OF DISTANT PULSARS WITH THE DISPERSION MEASURES MORE THAN 30 PC/CM^3

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For more than 40 years since the discovery of pulsars not a single such source with the dispersion measure value (DM) greater than 25 pc/cm^3 has been detected at decametre waves. Moreover: by 2010, all low-frequency radio telescopes of the world had detected the decametre radio emission of only about a dozen pulsars. However, in 2010-2013, the first decametre pulsar census was carried out on the UTR-2 radio telescope, which resulted not only in the redetection of these sources already known at decametre waves, but also in the first detection of another 30 pulsars at such low frequencies. Due to the high temperature of the galactic background and the scattering at low frequencies, the DM value of the pulsars sought was limited to 30 pc/cm^3.

The second similar census was carried out in 2020-2021. It was necessitated by a significant increase in the number of potentially available pulsars (with rotation periods greater than 100 ms, DMs < 30 pc/cm^3, and accessible for UTR-2 coordinates), which more than doubled from 2010 to 2020: from 74 sources during the first census to 163 pulsars – during the second one. The result was the detection of decametre radio emission of twenty more pulsars. One pulsar was also detected in 2014. Thus, by the end of 2021, 61 pulsars with DMs up to 30 pc/cm^3 were detected on decametre waves.

Nevertheless, even during the first census there were some attempts to detect more distant sources (with the DMs > 30 pc/cm^3). As a result, two such pulsars were detected (of the six sought), but a complete such census has never been conducted in the decametre waverange. At the end of 2021, we began conducting this census; its parameters and the first results (average pulse profiles, DM values, etc.) will be presented in this work.

RADIO SIGNAL FROM THE FIRST MOLECULES OF THE DARK AGES: CAN IT BE OBSERVED?

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A landmark event for the whole world has recently taken place – the launch of the James Webb Telescope, the main goal of which is to study the first stars and galaxies of our Universe in the infrared range. These studies clarify what the first stars and the first galaxies were. To understand how they could form, it is necessary to plan and develop millimeter and decameter radio telescopes that will indicate the conditions under which these objects formed (ionization and chemical composition of the gas and its temperature). To do this, it is necessary to evaluate the signal from the first molecules formed in the Dark Ages. The kinetics of the formation of the first H_2, HD, and HeH^+molecules in the Dark Ages, the population of their rovibrational levels, and the luminescence/absorption of the first molecules against the cosmic microwave background radiation caused by impact excitations of their rovibrational levels are calculated. We conclude that, within the framework of the standard cosmological model, the first molecules lead to partial absorption of cosmic microwave background quanta, distorting its spectrum. The amplitude of such distortion, however, is very small – one or two orders of magnitude less than the calculated sensitivity of the Voyage-2050 mission, aimed at measuring distortions in the CMB spectrum. Given the importance of receiving signals from the pre-stellar era of the Dark Ages, the design sensitivity of planned missions to measure cosmic microwave background distortion should be reviewed.

COMPARISON OF IONOSPHERIC SCINTILLATION CHARACTERISTICS AT THE MAXIMUM OF 23RD AND 24TH CYCLES OF SOLAR ACTIVITY

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Solar radiation is one of the main climate-forming factors. In recent decades, considerable attention has been paid to the study of the influence of solar activity on hydrometeorological processes. In particular, this is due to the problem of climate warming.

Until recently, the flux density of the total solar electromagnetic radiation at a distance of 1 AU from the star (solar constant S_O) was perceived as a constant value, the variations of which did not go beyond the measurement error. The installation of measuring equipment on artificial Earth satellites, starting from 1979, has significantly increased the accuracy of S_O determination. In particular, this made it possible to identify variations in the solar constant that are synchronous with 11-year solar cycles. The amplitude of such variations was 0.07% of the mean long-term S_O. This is a too small value. The question of detecting climate changes at time intervals of tens of years, which can be associated with these variations, remains open.

The terrestrial ionosphere is one of the geospheres and is involved in local and global processes of intergeospheric interaction and, at the same time, it is subject to a more pronounced effect of solar activity compared to hydrometeorological processes. In particular, this applies to ionospheric turbulence, the intensity of which can be judged from the nature of scintillations of compact cosmic radio sources. Depending on the time intervals at which the state of the ionosphere is considered, one can speak of ionospheric weather and ionospheric climate.

The data on the characteristics of ionospheric scintillations obtained by us with the URAN-4 radio telescope make it possible to consider the effects over time intervals of tens of years. In particular, to study the influence of 11-year variations of the solar constant on ionospheric turbulence, which relates to the issues of ionospheric climate. In this work, we carry out a comparative analysis of the characteristics of ionospheric scintillations at the maximum of 23 and 24 cycles of solar activity and compare the results obtained with the corresponding values of the solar constant.

RADIO MONITORING OF CASSIOPEIA A WITH THE GURT ARRAY IN METER AND DECAMETER WAVELENGTHS

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Observations of radio sources, Cassiopeia A and Cygnus A, in the frequency range 15–70 MHz have been implemented with two sections (subarrays) of the GURT radio telescope in the correlation mode. The distance between phase centers of the sections used is about 60 m. The correlation interferometer with a small base allows us to suppress the contribution of the Galactic background emission, the brightness temperature of which in the frequency range is quite high, $500 \cdot 10^3 – 10^3$ K. The geographical location of the GURT radio telescope contributes to radio observations of Cassiopeia A and Cygnus A at almost the same zenith angle about 9° at the time of their upper culmination. In this case, the parameters of the phased antenna array in the directions to the specified sources can be considered identical. In order to reduce the effect of ionospheric scintillations on the ratio of their source fluxes, the method of adaptive filtration was used.

The ratio of the source fluxes in the frequency band 15−70 MHz is taken in a discrete grid of frequencies 15, 20, 25, 30, 35, 38, 40, 45, 50, 55, 60, 65, 70 MHz. For the most reliable results, the values of the ratios of source fluxes at each frequency within the selected grid were averaged in frequency and day. The measured results at the frequency of 38 MHz were plotted together with the data obtained in previous years, which are in good agreement with the expected decrease in the flux density of Cassiopeia A. The secular decrease in the flux density from 1965 to 2019 in the frequency band 15−38 MHz is 1.12 ± 0.47% per year on average. At 38 MHz, this decrease is equal to 0.65 ± 0.21%.

OVERVIEW OF LOFAR LATVIA PAST AND FUTURE

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In the past years, the VIRAC team has done huge improvements to the LOFAR Latvia station. Installed several data recording softwares (iLiSA, LuMP). We have done first observations of CAS. A., CYG.A., Sun, Jupiter, ect. The results of these observations will be shown in this conference. Future technical upgrades will include connecting LOFAR station with VIRAC HPC. In the future we will start to observe pulsars. Over scientific work includes detecting lightning bursts on Jupiter, studying ionospheric scintillation, space weather.

We will create a system capable of sustained (24/7) LOFAR observations to monitor the ionosphere, and, using pre-recorded data, to fully exploit the ionospheric characterization capabilities of LOFAR. The data format will be dynamic spectra (station beam formed data) that will be used to classify different ionospheric conditions such as scintillation index (S4) [Waszewski2022], sporadic E, and wavelike structures (TIDs).

Additionally to processing single station observations we have also created a data processing tool for ILT data LAnDmARk. This tool allow 1) Data selection from LOFAR Long Term Archive (LTA https://lta.lofar.eu), 2) Data retrieval from LOFAR LTA, 3) Direction-independent processing of LOFAR LBA/HBA data via prefactor (v3) pipelines (https://github.com/lofar-astron/prefactor)

JUPITER SPORADIC DECAMETER RADIO EMISSION: THE MHD INSTABILITY AND SOURCE FORM

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There was looking for the instabilities in the Jupiter magnetosphere, which can lead to the formation of the L- and S-bursts of decameter radiation. There are analyzed a possible plasma, gravity, current, and magneto hydrodynamic instability of the magnetosphere at different altitudes of Jupiter. The properties of radiation and the conditions for formation of various types of bursts are taken into account. The shape of the sources of L- and S-types has been simulated.

It is shown that the active sources will be tied to the active regions of Jupiter's atmosphere, with eddy atmospheric processes, and their shape will be determined by the processes of plasma extraction of the source along the Jupiter's magnetic field. L-bursts at periodicity of 1-100 seconds are caused by maser mechanisms of EM waves generation under the influence of Alfvén waves

with lengths of about 10^3-10^4 km, which are associated with the development of helical instabilities in Jupiter's magnetosphere. S-bursts at periodicity of 0.005-0.02 seconds are caused by the mechanisms of resonance and linear transformation of the plasma waves into EM in Jupiter's magnetosphere. They are generated in active sources with the electron beams ejected and modulated by the magneto-sound waves, which causes a significant stratification of the plasma into thin filaments and connected with groove-like instability. The resonant conditions for effective wave transformation are fulfilled in the thin surface layers of the current-filament tubes. The fine boundaries of the regions of effective transformation will form us the fine sources that create sporadic burst activity of Jupiter's decameter radiation in the form of a variety of S-bursts with a fine structure and with an ultrafine directional diagram.

RELATION BETWEEN INTERPLANETARY AND IONOSPHERIC SCINTILLATIONS AT DECAMETER WAVELENGTHS AND THEIR CONNECTION WITH SOLAR TRANSIENTS

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Amplitude and phase scintillations on inhomogeneities of the interplanetary plasma and the Earth's ionosphere significantly affect radio astronomical observations at decameter wavelengths, in particular, interferometer ones. The level of turbulence in the interplanetary medium and, hence, the scintillation power increases under the influence of shock waves generated by coronal mass ejections (CME) and regions of the interaction of the fast and slow solar wind or corotating interaction regions (CIR). In this case, the phase scintillations of interferometer visibility increase significantly, that reduces the allowable time of coherent averaging and limits the sensitivity of instruments. CMEs and SIRs also cause various effects in the geosphere, in particular, they change different parameters of the ionosphere.

In decameter observations with the URAN interferometers, we have found that a high level of ionospheric scintillations at mid-latitudes correlates significantly with the increase in interplanetary scintillations driven by space weather. It is noted, that this relationship manifests itself even at a low value of the southern component of the interplanetary magnetic field during the solar transients and weak magnetic storms caused by them. Therefore, the measured indices of ionospheric scintillations can be used to determine quiet conditions in the interplanetary medium suitable for highly sensitive interferometer observations in the decameter range.

DYNAMIC PROCESSES IN THE "CORE-JET" SYSTEM OF ACTIVE GALACTIC NUCLEI BASED ON DATA OF RADIO FLUXES MONITORING AND VLBI OBSERVATIONS

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This project involves identifying interrelation between appearances of long-term and short-term variability various types of active galactic nuclei (AGN) and changes in images of spatial structure in "accretion disk-nucleus-jet" system according to VLBI data. Impetus for this work is results of ultra-high resolution Event Horizon Telescope about formation or absence jets in various AGNs. It is planned to carry out observations of interdiurnal and intra-day variability of large AGN sample on radio telescopes VIRAC (Latvia) and optical telescopes in Baldone (Latvia) and Vihorlat (Slovakia) observatories. AGN sample under study is based on observations at VIRAC radio telescopes (2017-2022). Plus, data from long-term monitoring of AGN variability from Michigan Radio Astronomy Observatory (USA) will provide identification long-term activity trends. Information about 420 AGN various types from MOJAVE VLBI monitoring program will be used to separate radio-fluxes of core and jet, to study dynamics of movement jet components depending on jet structure and core activity. It is planned to conduct VLBI sessions on European Radio-Interferometer EVN to detect short-term changes in AGN maps and analyze them using deep learning neural network method. The study of AGN emission variations in radio and optical ranges with VLBI data and modern analysis of spatial structures, create prospect of empirical modeling of dynamic processes in AGN.

PROPAGATION EFFECTS OF LOW-FREQUENCY PULSAR PULSES IN THE SOLAR CORONA PLASMA

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It is shown that under the conditions of the magnetically active plasma of the solar corona, such integral characteristics of the plasma as the dispersion measure (DM) and the rotation measure (RM) will depend on the frequency. These dependencies will be due to the presence of two branches of the refractive indices, one of which will correspond to an ordinary wave, and the other

to an extraordinary wave. Ultimately, the frequency dependencies will be determined by the polarization of the radiation, the presence or absence of an ordinary and/or extraordinary waves or they mixt, and the trajectory of radiation propagation with respect to the direction of the magnetic field and it strength. The effects of propagation of radio emission in a magnetically active plasma will be most contrasting at low frequencies. Thus, the study of pulsar pulses when pulsars close to their solar conjunction and/or the Jupiter-Io tube provides fundamentally new possibilities for determining the parameters of magnetically active plasma.

ANGULAR STRUCTURE OF THE RADIO GALAXY 3C239 IN THE DECAMETER RANGE

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The image of the radio galaxy 3C239, obtained using MERLIN at decimeter wavelengths, consists of two lobes several arcsec in size, separated by a distance of about 10 arcsec with compact hot spots in each of the lobes. We present the results of the observation of this radio galaxy with the URAN interferometers at the decameter wavelengths. According to our study, the source in this range consists of two components that coincide in position and size with the lobes of the radio galaxy observed at the decimeter wavelengths, and a compact component corresponding to one of its hot spots. Another hot spot is not detected due to its low flux density at decameter wavelengths. In addition, a region of extended radiation with low surface brightness was found, which surrounds the source lobes. The size of this halo is 28 arcsec, and its emission at the frequency of 25 MHz is about 20% of the total flux of the radio galaxy. The possible view of spectra of the radio source components and their variation in the range from decameter to decimeter waves are determined. It is noted that, in contrast to the high-frequency structure of 3C239, where radiation of the compact hot spots dominates, at decameter waves about 90% of the radio galaxy flux is provided by more extended components – the source lobes and the halo.