

# 16-th Odessa International Astronomical Gamow Conference-School

## “Astronomy and beyond: Astrophysics, Cosmology and Gravitation, Cosmomicrophysics, Radio-astronomy and Astrobiology”

(Ukraine, Odessa, Chernomorka, 14-20 August, 2016)

### PLENARY SPEAKERS

#### MAGNETIC CATAclySMIC VARIABLES: 40 YEARS OF NON-VANISHING SURPRISES

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The genealogy and highlights of research of magnetic cataclysmic variables (MCV) are reviewed. In 1976, one of the most striking discoveries was that of the presence in the radiation of AM Her of the circular polarization, which was changing with the same period as the linear polarization, radial velocities, flux in different regions. This sample of properties differs very significantly from that observed in previously known cataclysmic binary systems. The interpretation was that the magnetic white dwarf accretes matter via the accretion columns and the magnetic field is strong enough to channelize the accretion stream and to prevent formation of the accretion disk, contrary to previously known objects. These objects are called the “polars” (or AM Her – type stars), and their actual number in the on-line catalogue of Ritter and Kolb (2003A&A...404..301R) is 192 among 398004 variable stars registered in the VSX. The MCVs are typically subdivided into the groups of “classical” (“synchronous”, or AM Her – type) and “intermediate” (or DQ Her – type) polars. This crude classification should be completed by rare “asynchronous” (or nearly synchronous) polars (or BY Cam – type with V1432 Aql subtype) and “magnetic dwarf novae” (“outbursting intermediate polars”, or DO Dra – type).

The studies of these very exotic objects in Odessa were immediately initiated by Prof. V.P.Tsessevich (1907-1983) and are carried out by our group with many colleagues in different countries. Besides the authors, Ph.D. theses on MCVs in our group were defended by A.V.Halevin and A.V.Baklanov. The polarimetric monitoring was started in the Crimean Astrophysical Observatory by N.M.Shakhovskoy (1931-2011) and Yu.S.Efimov (1935-2011) and continued from 1989 by S.V.Kolesnikov. Further on, we started a project on rotational evolution of magnetic white dwarfs in intermediate polars. This activity is a part of the international "Inter-Longitude Astronomy" (ILA) project (2010OAP...23....8A), which also includes "super-humpers", "eclipsers", "Impactors" ("extreme direct impactors"), "Stellar bell" (pulsating stars), "Symbiosis"

(symbiotic stars) and "Novices" (newly discovered variables).

The highlights of the MCV studies are shown for the classical polars AM Her, QQ Vul, the eclipsing polar V808 Aur (CSS 081231:071126+440405), the asynchronous polars BY Cam, V1432 Aql, intermediate polars BG CMi, FO Aqr, AO Psc, V405 Aur, PQ Gem, MU Cam, V1323 Her, V2306 Cyg, V709 Cas, 1RXS J063631.9+353537, 1RXS J070407.9+262501, 1RXS J180340.0+401214, 1RXS J213344.1+510725).

#### АНОМАЛЬНЫЕ РЕНТГЕНОВСКИЕ ИСТОЧНИКИ И МЯГКИЕ ГАММА ПОВТОРИТЕЛИ – ЯВЛЯЮТСЯ ЛИ ОНИ МАГНЕТАРАМИ?

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ИКИ РАН и МИФИ*

Наблюдаемые свойства аномальных рентгеновских источников и мягких гамма повторителей (АРИ/МГП) указывают на необходимость существования источника энергии, отличающегося от вращательной энергии нейтронной звезды. Сделан анализ модели, в котором источник энергии связывается с диссипацией энергии магнитного поля в сильно замагниченной нейтронной звезде – магнетаре. Отмечается ряд несоответствий этой модели с наблюдательными свойствами, и теоретическими оценками.

Обсуждается альтернативный источник энергии, связанный с высвобождением ядерной энергии, запасенной в неравновесном слое во внешней коре нейтронной звезды. Вследствие развития неустойчивостей, ведущих к выносу неравновесного вещества во внешние слои нейтронной звезды, происходят ядерные взрывы различной мощности. Отмечается, что подобные явления могут происходить на нейтронных звездах малой массы, 0.5-0.8 солнечных.

#### GRAVITY-ANTIGRAVITY INTERPLAY IN THE LOCAL UNIVERSE

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The Local Universe at distances from 1 to 20 Mpc is a non-uniform and anisotropic astronomical system that

cannot be described by the standard model of cosmological expansion.

The major building units of the system are groups and expansion outflows of galaxies that are all embedded in the perfectly uniform dark energy background. Their dynamics and evolution are controlled by Newton's gravity produced mostly by dark matter and Einstein's antigravity produced by dark energy. We have developed a theory of the local gravity-antigravity interplay and used recent HST high accuracy observations to find out that gravity is stronger than antigravity in bound groups while antigravity is stronger than gravity in flows of expansion. The antigravity dominated accelerating expansion outflows present a new astronomical phenomenon revealing Einstein's universal antigravity in the Local Universe.

## РЕЗУЛЬТАТЫ ЗОНДИРОВАНИЯ ЯДРА И АТМОСФЕРЫ КОМЕТЫ ЧУРЮМОВА-ГЕРАСИМЕНКО НА ЗАВЕРШАЮЩЕЙ СТАДИИ КОСМИЧЕСКОЙ МИССИИ РОЗЕТТА

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Продолжается более чем двухлетнее зондирование ядра, комы и хвоста кометы Чурюмова-Герасименко в рамках уникальной космической миссии Розетта, которое завершится 30 сентября 2016 г. в связи с израсходованием запаса топлива орбитального модуля.

Космическая миссия "Розетта" была спланирована и осуществлена Европейским космическим агентством. Основной задачей, поставленной перед космической миссией Розетта, было изучение проблемы происхождения комет, связь между кометного и межзвездного вещества и их значение для происхождения Солнечной системы. Эти задачи были блестяще решены в течение длительного полета космического корабля "Розетта" с 2004 по 2016 годы к ядру периодической кометы Чурюмова-Герасименко, открытой в Киеве астрономами Киевского национального университета имени Тараса Шевченко Климом Чурюмовым и Светланой Герасименко. С помощью космической миссии Розетта было проведено исследование глобальных характеристик кометного ядра, определенные его динамические свойства, изучено морфологию поверхностного слоя ядра и его химический состав, изучены химический, минералогический и изотопный состав летучих и тугоплавких веществ в кометной ядре, определены физических свойствах и соотношении летучего и тугоплавкого компонента кометного ядра, осуществлен мониторинг развития кометной активности и физических процессов в поверхностном слое ядра и внутренней коме (взаимодействие газа и пыли), а также исследованы глобальные характеристики двух астероидов Штейнса и Лютеции, включая определение динамических параметров, поверхностной морфологии и состава этих малых планет.

Рассмотрены некоторые особенности проведения программы полета "Розетты" и состояние аппаратов после посадки "Фили" на ядро кометы. Газообразные составляющие комы кометы Чурюмова-Герасименко включают ряд соединений, указывающие на особенности возникновения небесного тела. По замерам

приборов, установленных на "Розетте" и "Филах", обнаружены пары воды, окись, двуокись и дисульфид углерода, аммиак, метан, метанол, формальдегид, сероводород, цианистый водород, диоксид серы, сера, натрия и магний, среди 16 сложных органических соединений впервые обнаружен с помощью прибора COSAC в комете 67P ацетамид -  $\text{CH}_3\text{CONH}_2$ , ацетон -  $(\text{CH}_3)_2\text{CO}$ , метилизоцианат -  $\text{CH}_3\text{NCO}$  и пропиональ -  $\text{CH}_3\text{CH}_2\text{CHO}$ . Ядро кометы имеет неправильную форму, оно состоит из двух частей "головы" и "тела", соединенных узкой перемычкой. На снимках "Розетты" видно грубые изломы поверхности, крутые горные склоны, испещренные провалами, хребтами и глыбами, покрытые раздробленным материалом небольшие равнинные поля. Выявлено, что ядро кометы 67P / Чурюмова-Герасименко состоит на ~ 75 процентов пыли и ~ 25 процентов льда. Космический аппарат "Розетта" обнаружил в облаке газа вокруг ядра кометы Чурюмова-Герасименко неожиданно большое количество молекул кислорода  $\text{O}_2$ , причем оказалось, что концентрация кислорода одинакова для всех областей кометы, что указывает на то, что кислород сохранился в материи кометы со времен формирования Солнечной системы. Также впервые были обнаружены молекулярный азот в ядра кометы Чурюмова-Герасименко, отношение содержания которого к содержащему  $\text{CO}$  указывает не только на фазу формирования  $\text{N}_2$ , но и про дальнейшую его тепловую. Отношение полутяжелой воды к обычной  $\text{DHO}/\text{H}_2\text{O} = 5.3 \times 10^{-4}$ , что в три раза больше, чем в земных океанах. Индукция магнитного поля в плазменном хвосте кометы  $B \approx 100$  нТ.

Подробно исследовано развитие кометной активности и образования комы и хвоста у кометы. Атмосфера вокруг ядра кометы образуется из выбросов газа и пыли многочисленными джетами (струями), крупные и мощные из которых расположены в районе перемычки, соединяющей меньшую часть (голову) с большим (телом). Представлены также результаты наземных наблюдений и исследований кометы Чурюмова-Герасименко.

## DIFFRACTION AT THE LARGE HADRON COLLIDER

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Diffraction phenomena play an important role in high-energy hadron scattering, in particular in proton-proton scattering at the Large Hadron Collider (LHC) at CERN. Their studies are important at least for two reasons. One is that diffractive processes, dominating in nearly forward scattering may overshadow rare processes related to the production of new particles. Without the knowledge and quantitative description of the diffractive "background" new effects cannot be identified. The second reason is that diffraction or forward physics cannot be treated in the framework of perturbative methods, e.g. by means of perturbative quantum chromodynamics (QCD).

I review recent theoretical work on elastic and inelastic diffraction at high energies and its role in the analysis of the experimental data at the LHC. The main topics are elastic scattering and diffractive dissociation (single, double and central). In elastic proton-proton scattering, two

structures, namely the small  $-t$  break and the diffractive minimum deserve attention and are discussed here. Neither of these structures, nor the rate of increase with energy of the total cross section can be predicted by theory. An important topics in my lecture is diffractive dissociation of the colliding nuclei. Special emphasis is laid on low missing-mass diffractive dissociation, rich of nuclear resonances, subject of intense studies at the LHC. Of special interest is exclusive central production that can be considered as a gluon factory producing glueballs.

### A NEW BÖHM-VITENSE GAP IN A-F SUPERGIANTS: POSSIBLE CONNECTION WITH VARIABLE STARS

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Highly precise temperatures and absolute magnitudes have been determined from line depth ratios for a set of 160 A-F-G Supergiants of about solar metallicity ( $-0.5 < [Fe/H] < +0.4$ ), based on high resolution, high S/N echelle spectra.

A new gap has been discovered in the distribution of Supergiants in the temperature range 7100 to 7200 K.

A possible connection with variable stars is discussed.

### SOLAR PROTON EVENTS OF THE SOLAR CYCLES 23-24: OBSERVATIONS, FEATURES, INTERPRETATIONS

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Based on the new Catalogue of solar proton events (SPEs) for the period of 1997-2009 (solar cycle 23) we revisit the long-studied problem of the event size distributions in the context of those constructed for other solar flare parameters. Recent results on the problem of size distributions of solar flares and proton events are briefly reviewed. Even cursory acquaintance with this research field reveals rather mixed and controversial picture. We concentrate on three main issues: 1) SPE size distribution for  $>10$  MeV protons in solar cycle 23; 2) size distribution of  $> 1$  GV proton events in 1942-2014; 3) variations of annual numbers for  $>10$  MeV proton events at long-term scale (1955-2015). Different results are critically compared; most of the studies in this field are shown to suffer from vastly different sets as well as from insufficient knowledge of underlying physical processes in the SPEs under consideration. New studies in this field should be made on more distinct physical and methodological bases. It is important to note evident similarity in size distributions of solar flares and superflares on the Sun-like stars.

We also present a study of the largest SPEs of current solar cycle 24 (from 2009 January up to date), including some really observed and "hidden" Ground Level Enhancements (GLEs) of solar cosmic rays (SCRs). The results tend to support the concept of proton acceleration by the CME-driven shock, even though the possibility exists of particle acceleration at flare site, with subsequent perpendicular diffusion of accelerated particles in the IMF (interplanetary magnetic field). The integral time-of-maximum (TOM) spectra of solar protons (as a proxy of SEP spectrum in the source) may be approximated in some SPEs by a broken power-law with an exponential tail (cutoff).

### CHEMICAL COMPOSITION OF THE PLANET-HOSTING STARS

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Analysis of different indicators of a connection between the chemical abundance and the presence of various mass planets is presented. We used our database ( $\sim 600$  stars) that was created by the research group of the Astronomical Observatory of the Odessa National University (Mishenina et al. 2008, 2012, 2013, 2015). For this work 150 dwarfs with the effective temperatures in the range of 5500 - 6200 K and metallicities  $[Fe/H]$  are more than  $-0.5$  dex were selected. Among them there are 14 planet hosting stars. The investigation of the relations of metallicity, abundance of elements from Li to Eu, dependencies of the difference of refractory and volatile element's abundances on condensation temperature  $T_{cond}$ , with the presence of planets was conducted.

### ИЗОЭНТРОПИЧЕСКИЕ "УДАРНЫЕ ВОЛНЫ" ПРИ ЧИСЛЕННОМ МОДЕЛИРОВАНИИ В АСТРОФИЗИЧЕСКИХ ЗАДАЧАХ

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Рассмотрена задача о сильных разрывах в решении уравнений газовой динамики в предположении изоэнтропичности, т.е. непрерывности энтропии на разрыве.

Представлено сравнение решения для стандартной ударной волны, где используется условие непрерывности энергии на разрыве, и для изоэнтропической "ударной волны".

Показано, что численное моделирование астрофизических задач, в которых встречаются ударные волны большой амплитуды (взрывы сверхновых, моделирование джетов), с использованием сохранения энтропии, вместо сохранения энергии, приводит к большим ошибкам при расчете ударных волн. Применение изоэнтропических уравнений газовой динамики допустимо только в случае, когда течение является в течении газа отсутствующими сильными разрывами решения, либо

когда интенсивность ударных волн невелика и они не оказывают существенного влияния на течение.

### **DENSITY AND VELOCITY OF MATTER AND DARK ENERGY IN GREAT VOIDS: THEORY AND OBSERVATIONS**

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We study the evolution of cosmological perturbations which leads to the formation of great voids in the large-scale structure of the Universe. We assume that perturbations are spherical and all components of the Universe – radiation, matter and dark energy – are continuous media with ideal fluid energy-momentum tensors, which interact only gravitationally. The equations of evolution of perturbations in the comoving to cosmological background reference frame for every component are obtained from the equations of conservation law and Einstein's ones and are integrated by the modified Euler method. The initial conditions are set at the early stage of evolution in radiation-dominated epoch, when the scale of perturbation is much larger than the particle horizon. We investigate the evolution of spatial distributions of density and velocity profiles for every component in the void. We study also the dependences of the void observational parameters on the parameters of dark energy model, in particular, on effective speed of sound and equation of state parameter. We show that ratio of the amplitudes of spatial distributions of peculiar velocity of galaxies and matter density perturbation in voids is sensitive to equation of state parameter of dark energy and weak depends on amplitude and density profile of initial perturbation. We analyse the possibility to use the observational data on internal dynamics of voids for testing the models of dark energy.

### **SPATIOTEMPORAL DISTURBED EARTH'S MAGNETIC FIELD: ENVIRONMENTAL ASPECT**

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The report is devoted to the study of the Earth's magnetic field spatiotemporal structure, spatiotemporal geomagnetic field variations of the planet and Ukraine territory, its perturbations, and the development of new disturbance estimation criteria, and some aspects of their use. Series of the magnetic field maps and maps of its disturbance are built. The results are used for a detailed study of magnetic field dynamics, for learning of the magnetic field disturbance, for justification of magnetic field's environmental standards, and for the study of relationship with the Earth's seismic activity, as well as certain phenomena in the biosphere.

### **PROBING AND IDENTIFYING NEW PHYSICS SCENARIOS AT INTERNATIONAL LINEAR COLLIDER**

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Numerous non-standard dynamics are described by contact-like effective interactions that can manifest themselves in  $e^+e^-$  collisions only through deviations of the observables (cross sections, asymmetries) from the Standard Model predictions. If such a deviation were observed, it would be important to identify the actual source among the possible non-standard interactions as many different new physics scenarios may lead to very similar experimental signatures. Here we study the possibility of uniquely identifying the indirect effects of  $s$ -channel sneutrino exchange, as predicted by supersymmetric theories with R-parity violation, against other new physics scenarios in process  $e^+e^- \rightarrow \mu^+\mu^-$  at the International Linear Collider. To evaluate the identification reach on sneutrino exchange, we use as basic observable a double polarization asymmetry,  $A_{\text{double}}$ . Also, we examine the effects of neutrino and electron mixing with exotic heavy leptons in the process  $e^+e^- \rightarrow W^+W^-$  within  $E_6$  models, in particular, the possibility of uniquely distinguishing and identifying such effects of heavy neutral lepton exchange from  $Z - Z'$  mixing.

### **ABOUT FUNDAMENTAL PROPERTIES OF SOLAR CYCLES AND NEED TO REVIEW THEIR INTRODUCTIONS**

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Currently it is accepted that the introduction of solar cycles is on average monthly data and their smooth values for various indexes from the entire solar disk. This aggregate view creates an illusion of monotony of modify indexes on all phases of the solar cycle. Based on activity data of Northern (N) and Southern hemispheres (S) received by the method of wavelet analysis and Fourier filtering strip, the existence of "hidden" properties of solar cycles is shown, which were not previously accounted. We examined daily and monthly average indices of total area groups spots - SpN and SpS (1874-2016 years), Wolf numbers WN and WS (1940-2016 years), Flare index FN and FS (1966-2006 years). These indices are mutually complementary in introducing the power, the number of activity centres and flare processes. Among the detected differences in N and S cycles: time of the start and the end, properties of discreteness, the dynamics of the main periods, intervals of a coherent and joint time manifestation, time of maximum, spotless days interval, time of "crashing" and "synchronization". It is shown that the degree of influence of N and S processes of solar activity on the Earth depends on its position on the orbit. There are periods of dominance of N or S activity and the time when they are acting simultaneously. The results obtained can

be the basis for the prediction of the development of the solar cycles and the nature of the manifestations of the solar-terrestrial relationship.

### **SOFTWARE FOR AUTOMATED ASTEROIDS AND COMETS DISCOVERIES COLITEC: SATELLITE OBSERVATIONS**

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Software for automated frames processing of asteroid surveys given as series of frames are necessary for the most effective astronomical observations.

This possibility is provided by the CoLiTec software that allows not only to detect asteroids, but also to perform astrometric measurements in real time.

Full reliability of the detection of moving objects is retained up to the lower limit of SNR equal to 3 units in case of a minimum series consisting of four frames, with no stars covering of asteroid.

CoLiTec software support multi-threaded support for multi-cores systems and local network, working with very wide field of view (up to 10 degrees) and automatic detection of faint moving objects (SNR > 2.5).

The OLDAS mode is especially significant. It allows for near real-time data processing and assigns confirmation of the most interesting objects at the night of their preliminary discovery.

CoLiTec software equipped with the modern viewer of obtained results with a user-friendly GUI. A mobile version of the viewer is available. CoLiTec processing results can be monitored from anywhere in the world.

Pipeline for digital video processing has been developed. It is presented as a flexible platform for receiving and processing video in any resolution, as well as easy integration of different modules required to improve image quality, delineation and recognition of moving objects in the video series.

Also CoLiTec software can be used for surveillance and detection satellites. satellite detection can be performed using the matched filter and the determination of the exact position using fitting CoLiTec.

### **DECADE NONSTABILITIES IN EARTH'S ROTATION AS EVIDENCES OF THE DRIFT OF LITHOSPHERE OVER ASTENOSPHERE**

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The decade instabilities in Earth's rotation (DIER) are usually explained by the interactions of the Earth's core and mantle. This hypothesis explains well a close correlation between DIER and the variations in the rate of the westward drift of the geomagnetic eccentric dipole; it corresponds quite reasonably to the possible redistribution of the angular momentum between the fluid core and the

mantle of the Earth. However, the hypothesis can not explain the close correlations of DIER with the observable variations in the masses of the Antarctic and Greenland ice sheets, with the decade oscillations of the types of synoptic processes (the epochs of the atmospheric circulation), with the anomalies of the global temperature, regional anomalies of the cloudiness, precipitation, and other climatic characteristics.

It is supposed that the DIER are the fluctuations of the velocity of the lithosphere driftage along the asthenosphere. The sliding of the lithosphere over the asthenosphere is possible due to of the vibratory displacement mechanism by tidal forces. The consequences following from this hypothesis are discussed.

### **HOT DENSE MAGNETIZED SPINOR MATTER IN PARTICLE AND ASTROPARTICLE PHYSICS: THE ROLE OF BOUNDARIES**

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Properties of hot dense ultrarelativistic spinor matter in a slab of finite width, placed in a transverse uniform magnetic field, are studied. The admissible set of boundary conditions is determined by the requirement that spinor matter be confined inside the slab. In thermal equilibrium, the chiral separation effect in the slab is shown to depend both on temperature and chemical potential; this is distinct from the unrealistic case of the magnetic field filling the unbounded (infinite) medium, when the effect is temperature-independent. In the realistic case of the slab, as temperature increases from zero to large values, a stepped-shape behaviour of the axial current density as a function of chemical potential is changed to a smooth one.

A choice of the boundary condition can facilitate either amplification or diminution of the chiral separation effect; in particular, the effect can persist even at zero chemical potential, if temperature is nonzero. This points at a significant role of boundaries for physical systems with hot dense magnetized spinor matter, i.e. compact astrophysical objects (neutron stars and magnetars), relativistic heavy-ion collisions, novel materials known as the Dirac and Weyl semimetals.

### **ASTROINFORMATICS AS A NEW RESEARCH FIELD.**

### **UKRVO ASTROINFORMATION RESOURCES: TASKS AND PROSPECTIVE.**

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The data-oriented astronomy has allowed classifying the *Astroinformatics* as a new academic research field, which covers various multi-disciplinary applications of the e-Astronomy. Among them are the data modeling, data mining, metadata standards development, data access, digital astronomical databases, image archives and visualization, machine learning, statistics and other

computational methods and software for work with astronomical survey and catalogues with their giga- to tera-bytes and more amount of astroinformation resource.

Astroinformatics was initially developed as a part of the virtual observatory tools to retrieve the data through web-based interfaces. The International Alliance of Virtual Observatories (IVOA) was formed with this aim, and Ukrainian Virtual Observatory (UkrVO) is the IVOA member from 2012.

In this report we describe briefly, first of all, the different applications and services of astroinformatics, including in education and in repurposing archival data for new projects. Secondly, we present the data releases of the Joint Digital Archive of the Ukrainian Virtual Observatory, which were performed by scientists from Kyiv, Mykolaiv, Odesa, L'viv and Crimea, including those in a tight international cooperation. The UkrVO Data Release 1 deals with the star catalogues (FON, Polar zone, open clusters, GRB star fields) as well as the UkrVO Data Release 2 deals with the Solar System bodies (giant and small planets, astronomical heritage images), which have been obtained from the digitized astroplates and were organized as the UkrVO Joint Digitized Archive database of astroplate network collections.

## АСТРОНОМИЧЕСКИЙ СЕКТОР ИССЛЕДОВАНИЙ ПРОБЛЕМЫ SETI: ИТОГИ И ПЕРСПЕКТИВЫ

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После обоснования радиоастрономического метода поиска ВЦ на длине волны излучения водорода 21.1 см [1], следующим шагом явилась выработка стратегии их обнаружения, основу которой, как следует из предложенной Дрэйком формулы для числа одновременно существующих цивилизаций в Галактике [2], составляют астрономические параметры. Именно астрономические данные определяют целесообразность постановки задачи о поиске ВЦ и связи с ними. Так, если число одновременного существования ВЦ  $N_{ВЦ} < 1$ , при размерах Галактики 100 000 световых лет, вероятно, бессмысленно тратить усилия на их обнаружение. Если же  $N_{ВЦ} > 1$ , а тем более,  $N_{ВЦ} \gg 1$ , следует искать пути решения сформулированной проблемы.

К астрономическим параметрам формулы Дрэйка относятся: число звезд в Галактике –  $N$  и вероятностей наличия: у звезд планетных систем –  $f_1$ , и планет пригодных жизни –  $f_2$ , с возрастом достаточным для не только для её зарождения, а и достижением уровня разумной цивилизации. Оценка этих вероятностей и остальных,  $f_i$ , (относящихся с сферам исследования биологии, социологии и др. наук), производилась путем экспертных оценок, поскольку объективных предпосылок для их вычисления в 1960-70-е гг. не было разработано. Ситуация изменилась только с 1980-х годов, после 20-ти летнего активного обсуждения проблемы ВЦ на представительных международных конференциях [3-6]. Был предложен метод оценки и формула для вычисления вероятности наличия у звезд планетных систем [7], и большое число методов поиска планет у звезд [4, 6]. Начиная с 1990-х годов планеты у звезд начали открывать систематически,

достигнув в 2016 году числа открытых планетных систем у звезд и субзвезд свыше 2500 [8].

За последние 55 лет исследований удалось определить все астрофизические параметры формулы Дрэйка. Уточнено число звезд (и субзвезд) в Галактике, вычислено долевое содержание у них планетных систем, начали открывать планеты в зоне жизни. Этому процессу исследований и их основным результатам посвящена представленная работа. Обсуждаются также перспективы исследования внесолнечных планетных систем.

1. Cocconi G., Morrison P. // Nature, 1959. V. 184. P. 844.
2. Drake F.D. // Green. Bank, USA., 1961. Nov.
3. Межзвездная связь // М.: Мир, 1965. 324 с.
4. Проблема SETI (Связь с внеземными цивилизациями) // М.: Мир, 1975. 352 с.
5. Проблема поиска внеземных цивилизаций // М.: Наука, 1981. 264 с.
6. Проблема поиска жизни во Вселенной // М.: Наука, 1986. 256 с.
7. Александров Ю.В., Захожай В.А. // Астрон. вестн., 1983. Т. 17, № 2. С. 82.
8. <http://exoplanet.eu/catalog>

## THE LARGE SCALE STRUCTURE OF THE LATE UNIVERSE: MECHANICAL APPROACH AND COUPLED PERFECT FLUIDS

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We consider the Universe at the late stage of its evolution and deep inside the cell of uniformity. At such scales, the Universe is highly inhomogeneous and is filled with inhomogeneities in the form of discrete distributed galaxies and the groups of galaxies. In the late Universe, these inhomogeneities have extremely non-relativistic peculiar velocities. We also suggest that the Universe is filled with a perfect fluid which can mimic dynamical dark energy.

This perfect fluid is considered in a very specific form concentrating around the inhomogeneities. In this sense, the inhomogeneities (e.g. galaxies) and fluctuations of perfect fluids are coupled with each other. Within the mechanical approach, which takes into account the discreteness of inhomogeneities, we consider the theory of scalar perturbations. We clarify some important points of this approach and conditions under which coupled perfect fluids can exist. We present also some examples of coupled perfect fluids.

# COSMOLOGY, GRAVITATION, ASTROPARTICLE PHYSICS, HIGH ENERGY PHYSICS

## PERFECT FLUIDS AS SOURCES OF SCALAR COSMOLOGICAL PERTURBATIONS

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In the framework of self-consistent theory of scalar cosmological perturbations, being suitable for all (sub-horizon and super-horizon) scales, we investigate the models with discrete matter sources (e.g. galaxies) and extra perfect fluids which have constant parameters of equations of state. Considering late stages of the Universe evolution, we derive the single equation determining the scalar perturbations and covering the whole space as well as define the corresponding universal Yukawa interaction range.

## THE SOLUTION OF THE COSMOLOGICAL CONSTANT PROBLEM AND THE FORMATION OF THE SPACE-TIME CONTINUUM

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The application of the microscopic theory of superconductivity to describe the early Universe makes it possible to solve the problem of dark energy, since in the cosmological models with superconductivity (CMS) this problem is solved in a natural way: dark energy is the result of pairing of primary fermions with the Planck mass, and its calculated density is equal to  $6 \cdot 10^{-30} \text{ g/cm}^3$  and coincides well with data of PLANK collaboration. At the same time the birth of space-time domains can also be described in the proposed model. Characteristic parameters of interaction of primary fermions determine the changes of the scale and values of different, but conjugate with each other, phase transitions – for the dark energy, the observed evolving Universe and other component of the condensate of primary fermions. Thus, there are several kinds of condensate formed by the primary fermions. They are different phases of condensed fermionic gas or liquid. As far as the fermionic condensate is a quantum object, the same primary fermions can form different phases, which correspond to different spatial and temporal domains with different dimension and amount of energy. Black holes are also described as a special form of condensate. Wherein such topological defects as the vortices arising in the forming phase, can be identified with the galactic proto-nuclei. That resolves the paradox of small time of formation of supermassive “black holes” with masses greater than the mass of the Sun observed at large  $z$ . However, in the model with superconductivity the proto nuclei of galaxies with the necessary weight appear naturally.

## THE REDUCTION OF ENTROPY IN THE OBSERVABLE UNIVERSE AND THE NATURE OF IRREVERSIBLE COSMOLOGICAL TIME

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In the cosmological model with superconductivity formation of space-time is described by a process of condensation of primary fermions with the Planck mass. Such a process is a second order phase transition, going with decreasing of entropy. Therefore, the evolution of the universe in the time is also described as a phase transition, going with a decrease of entropy inside the event horizon and a formation of ordered cosmic and biological structures. At the same time, however, the global entropy does not decrease. And the flow of the processes of decreasing of the entropy of galaxies gas under the influence of antigravitating dark energy agrees with that, because, according to Friedman equations, all forms of energy density determine the time evolution. This implies description of the nature of the cosmological time as an indicator of the phase transition, which explains the nature of the irreversibility of the real physical time, as well as its connection with the emergence of new qualities and structures of evolving objects. It differs in this from the abstract and reversible mathematical time, commonly used in mathematical equations, describing the physical processes.

## COUPLED SCALAR FIELDS IN THE LATE UNIVERSE: THE MECHANICAL APPROACH AND THE LATE COSMIC ACCELERATION

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We consider the Universe at the late stage of its evolution and deep inside the cell of uniformity, filled with dust-like matter in the form of discretely distributed galaxies, a minimally coupled scalar field and radiation as matter sources. We investigate such a Universe in the mechanical approach – this means that the peculiar velocities of the inhomogeneities (in the form of galaxies) as well as fluctuations of other perfect fluids are non-relativistic. We investigate the conditions under which a scalar field can become coupled, and show that, at the background level, such coupled scalar field behaves as a two component perfect fluid: a network of frustrated cosmic strings and a cosmological constant. Hence, the coupled scalar field can provide the late cosmic acceleration.

**THE RESULTS OF SYSTEM SPECTRUM  
ANALYSIS OF THE GRAVITATIONAL WAVE  
GW150914 SIGNAL**

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System spectral analysis using a number of integral linear and non-linear transformers of time dependence of gravitational wave GW150914 signal are performed with high time and frequency resolutions. Detailed features of signal are detected.

**BLACK BRANE WITH EXTRA-DIMENSION  
RICCI-FLAT COMPACTIFICATION IN THE  
PRESENCE OF SCALAR FIELD**

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In the framework of the Kaluza-Klein model with compactification of extra dimensions on a general Ricci-flat space, we construct the weak gravitational field of a compact massive source. It is shown that generally such a model contradicts to the gravitational tests in the Solar system. The role of tension (negative relativistic pressure) and of scalar source is investigated in the context of such a contradiction. It is shown that the solution of black brane type is the only one for which the empirical restrictions can be satisfied.

**QUALITATIVE CLASSIFICATION OF  
COSMOLOGICAL SCENARIOS  
IN A HYDRODYNAMICAL MODEL WITH  
BAROTROPIC EQUATION OF STATE**

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We study a qualitative behavior of the scale factor and energy density in a hydrodynamical model of a homogeneous isotropic Universe with a general barotropic equation of state (EOS). We relax conditions on EOS as compared with the paper by Jenkovszky et al., [Phys. Rev. D 90, 023529 (2014)] and to include the cases of two or more points of zero specific enthalpy. We present a classification of possible scenarios with an asymptotically exponential inflation, analogs of the Big Rip in the future and in the past, singularity free bouncing solutions and oscillating Universes.

**TOWARD THE QUANTIZATION OF BLACK  
HOLES**

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In order to construct a quantum model of black hole (BH), we introduce a modified description of classical space-time BH (the Schwarzschild solution). We develop the Lagrangian formalism of the vacuum gravitational field in spherically symmetric space-time  $D = D_- \cup D_+$ , divided on the two regions,  $D_-$  and  $D_+$  (R- and T- regions). Metrics of the regions  $D_-$  and  $D_+$  is taken in the scale-invariant form:

$$D_-: ds_-^2 = \left( \frac{R_g^2}{4} \right) \left[ \frac{n_- + u_-}{n_- - u_-} e^{\rho_-} d\eta_-^2 - \frac{n_- - u_-}{n_- + u_-} dx_-^2 - (n_- + u_-) d\sigma^2 \right],$$

$$D_+: ds_+^2 = \left( \frac{R_g^2}{4} \right) \left[ \frac{u_+ - n_+}{u_+ + n_+} e^{\rho_+} d\eta_+^2 - \frac{u_+ + n_+}{u_+ - n_+} dx_+^2 - (u_+ + n_+) d\sigma^2 \right],$$

where  $u_- = u_-(\eta_-)$ ,  $n_- = n_-(\eta_-)$

$$u_+ = u_+(x_+), \quad n_+ = n_+(x_+),$$

$$x_{\pm}^0 = (R_g/2)\eta_{\pm}, \quad r_{\pm} = (R_g/2)x_{\pm}.$$

The Hilbert-Einstein action is written in the form

$$S = \int_0^1 L_- d\eta_- + \int_1^{\infty} L_+ dx_+, \text{ where}$$

$$L_- = \frac{1}{\chi} \left[ (\dot{u}_-^2 - \dot{n}_-^2) e^{-\rho_-/2} + e^{\rho_-/2} \right], \quad L_+ = \frac{1}{\chi} \left[ (u_+^2 - n_+^2) e^{-\rho_+/2} + e^{\rho_+/2} \right].$$

Variations  $L_-$  and  $L_+$  by  $\rho_{\pm}$  lead to the constraints. By imposing gauge conditions  $e^{\rho_{\pm}/2} = 1$ , we construct the mass function and the Hamiltonian function, which vanishes on the solutions. Note that their Poisson bracket vanishes as well. We construct the Hamiltonian operator  $\hat{H}$ , and mass operator  $\hat{M}$ , in the minisuperspace. It turns out that  $[\hat{H}, \hat{M}] \sim \hat{H}$ , thus  $[\hat{H}, \hat{M}] \Psi = 0$  on the solutions of quantum equations  $\hat{H}\Psi = 0$ . The Eigen functions of the mass operator ( $\hat{M}\Psi = m\Psi$ ) are sought together with a solution of equation  $\hat{H}\Psi = 0$ . Using the compatibility condition these equations, we obtain the following wave functions:

$$D_{\pm}: \Psi_{\pm} = \frac{C_{\pm} |u_{\pm} - n_{\pm}|}{\sqrt{(u_{\pm} - 1)^2 - (n_{\pm} - 1)^2}} J_1 \left( \mu^2 \sqrt{(u_{\pm} - 1)^2 - (n_{\pm} - 1)^2} \right).$$

Here  $J_1(z)$  are Bessel function,  $\mu = m/m_{pl}$ ,  $C_-$  and  $C_+$  are normalizing constants.



## QUANTUM BOUND STATES ON THE NAKED REISSNER-NORDSTRÖM BACKGROUND

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We present a quantum mechanical study of the stationary states allowed for neutral test particles in the gravitational field of the Reissner-Nordström naked singularity. An analytical solution to the Klein-Gordon equation is obtained in terms of the confluent Heun functions. The case in which these wave functions describe bound states of the particle is examined and the corresponding energy spectrum is calculated. Further, we consider the Dirac equation also allowing for bound states and estimate the effect of the particle spin. Finally, the half-lives and characteristic radii of the bound states are discussed in conjunction with the possibility that they can be observed in nature.

## QUASI-ANALYTICAL METHOD FOR IMAGES CONSTRUCTION FROM $N$ – POINT GRAVITATIONAL LENSES

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In the construction of images that are created by the gravitational lens, we have a standard calculation problem: install all the roots of the system of equations lens. The analytical solution of this problem proves the existence of the set of roots, but does not give them a constructive algorithm for accurate calculation anyway.

In this case it is necessary to apply to numerical or analytically-numerical methods. The system of equations with two variables, in particular cases, equivalent one equation with one variable. The solution to this problem, both numerically and analytically in this case is much easier. But, with the exception of special cases, we have to deal with the system of equations in two variables.

Standard numerical methods are unstable and cannot provide the necessary accuracy of calculations. In the case where the gravitational lens equation polynomial, we are developing a different approach, using methods of algebraic geometry. In particular, there is an analytical method for the elimination of variables from a system of nonlinear algebraic equations and reduction solutions to search for the roots of polynomials. The calculation of roots of the polynomial by numerical methods is not a difficulty.

We note also that in algebraic geometry there are theorems which ensure that all the roots are found the initial system of equations. As an example of the above method, we calculated the image from two and three point lenses and compared them with images obtained earlier by tracing method.

It should be noted that our new method is both more accurate and more fast-acting.

## ОБ ЭЛЕКТРОВАКУУМНЫХ МОДЕЛЯХ В ОТО

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Известная программа Уилера 1955 г. построения вакуумных моделей в ОТО, соответствующих массе без массы и заряду без заряда, столкнулась с трудностью, связанной с тем, что сферическое симметричное гравитационное поле в вакууме обладает сингулярностью (поле Шварцшильда).

Как известно, инварианты волнового электромагнитного поля равны нулю по определению. Предлагается перестроить лагранжиан свободного гравитационного поля таким образом, чтобы скалярная кривизна вакуумной модели также тождественно обращалась в нуль (а не обращалась в нуль как решение полевых уравнений исследуемой модели). В общем случае пространство-время в таких моделях описывается недиагональной метрикой. Обсуждаются свойства простейших моделей.

## «CLUSTER CARTOGRAPHY»: ДЕТАЛЬНЫЙ АНАЛИЗ МОРФОЛОГИЧЕСКИХ ОСОБЕННОСТЕЙ СКОПЛЕНИЙ ГАЛАКТИК

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Мы представляем новую версию программы «Cluster Cartography», предназначенной для визуализации скоплений галактик каталога [1]. Кроме построения карт скоплений [2], новая версия позволяет определить степень концентрации скопления к центру или к ярчайшей галактике, наличие признаков анизотропии в распределении галактик в поле скопления и направление пояса повышенной плотности галактик в соответствии с обобщенной схемой Панько [3]. Дополнительно программа позволяет построить распределение эллиптичностей галактик, что дает оценку соотношения эллиптических и дисковых галактик в скоплении в соответствии с работой [4].

Мы применили программу «Cluster Cartography», к 19 изолированным скоплениям галактик. Результаты обсуждаются.

1. Panko E., Flin P.: 2006, *J. Astron. Data*, **12**, 1.
2. Panko E.A. Emelyanov S.I.: 2015, *Odessa Astron. Publ.*, **28**, 135.
3. Panko E.A.: 2013, *Odessa Astron. Publ.*, **26**, 90.
4. Panko E., Flin P.: 2014, *Odessa Astron. Publ.*, **27**, 32.

## МОРФОЛОГИЯ БОГАТЫХ СКОПЛЕНИЙ СО ЗНАЧИТЕЛЬНОЙ ЭЛЛИПТИЧНОСТЬЮ РЕНТГЕНОВСКОГО КОМПОНЕНТА

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Мы провели детальный анализ особенностей морфологии 35 богатых скоплений каталога [1]. Рентгеновские аналоги этих скоплений показывают значительную эллиптичность. Морфологические типы скоплений были определены в соответствии с обобщенной схемой Панько [2] с использованием программы «Cluster Cartography», первая версия программы описана в [3]. Дополнительно по распределению эллиптичностей галактик в этих скоплениях мы оценили соотношение эллиптических и дисковых галактик. Результаты обсуждаются.

1. Panko E., Flin P.: 2006, *J. Astron. Data*, **12**, 1.
2. Panko E.A.: 2013, *Odessa Astron. Publ.*, **26**, 90.
3. Panko E.A., Emelyanov S.I.: 2015, *Odessa Astron. Publ.*, **28**, 135.

## DARK MATTER IN THE DYNAMIC OF UNIVERSE

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Long time was considered, that in dynamics of the Universe as single whole, and its separate parts, the dominating role is played with usual star-shaped baryon substance. On its amount depends, what of models: unclosed, flat or closed, will feature its development, what dynamic script most approaches for exposition of its evolution. Enumerating all star-shaped substance or locally estimating a denseness of substance in the Universe, it is possible to do prognoses on the further evolution of the world, to build models with various dynamic scripts.

However, second half XX centuries in scientific custom included other physical concept – the latent mass or a dark substance (dark mater). Except for a gravitational interaction, it does not exhibit itself and does not disclose any other methods. But by gravitational interactions as separate galaxies, their groups and clusters, and the Universe as the whole, the dark matter plays a dominating role. On different estimates, its amount exceeds usual visible substance at 5-20 time, i.e. approximately on an order of magnitude.

## INFLUENCE OF ADDITIONAL DIMENSIONS ON DYNAMICS OF EXPANSION OF THE UNIVERSE

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It is considered possibility influences of additional dimensions on dynamics of expansion of our universe. It is proved, that this influence is expressed only through anisotropy parameter of additional dimensions. In the isotropic (in relation to additional dimensions) case dynamics of our world remains constant. All calculations were carried out for single-component ideal fluid with power diagonal metrics. The dynamic characteristics of the scale factor have allowed us to draw a conclusion about the physical nature of the initial substance.

## СТРУКТУРА НЕРИМАНОВОЙ АФФИННОЙ СВЯЗНОСТИ НА ГЛАДКОМ МНОГООБРАЗИИ И ОСТРОВНЫЕ МОДЕЛИ В ГРАВИТАЦИОННЫХ ТЕОРИЯХ

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Изучается структура аффинной связности (объекта параллельного перенесения) в общем случае с учетом неметричности и кручения на гладком многообразии.

Чтобы на многообразии  $M$  задать аффинную геометрию, необходимо и достаточно задать три тензорных поля: метрику, кручение и неметричность: все три объекта можно задать независимым образом, и в различных математических и физических моделях их нужно рассматривать как независимые переменные.

Обсуждаются ограничения, накладываемые на тензор кручения и тензор неметричности в островных моделях, включающих электромагнитное поле, которое позволяет рассматривать эти модели, как вакуумные образования соответствующего искривленного пространства-времени.

## GRAVITY-DRIVEN ACCELERATION AND KINETIC INFLATION IN A NONCOMMUTATIVE BRANS-DICKE SETTING

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By assuming the spatially flat FLRW line-element and employing the Hamiltonian formalism, a noncommutative (NC) setting of the Brans-Dicke (BD) theory is introduced. We investigate gravity-driven acceleration and kinetic inflation in this noncommutative BD cosmology.

Despite to the commutative case, in which both the scale factor and BD scalar field are obtained in power-law forms (in terms of the cosmic time), in our herein NC model, we see that the power-law scalar factor is multiplied by a dynamical exponential warp factor. This warp factor depends on not only the noncommutative parameter but also the momentum conjugate associated to the BD scalar field. For very small values of this parameter, we obtain an appropriate inflationary solution, which can overcome problems within BD standard cosmology in a more efficient manner. Moreover, we see that a graceful exit from an early acceleration epoch towards a decelerating radiation epoch is provided. For late times, due to the presence of the noncommutative parameter, we obtain a zero acceleration epoch, which can be interpreted as the coarse-grained explanation.

### INFLUENCE OF $\sim 7$ KEV STERILE NEUTRINO DARK MATTER ON THE PROCESS OF REIONIZATION

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Recent reports of a weak unidentified emission line at  $\sim 3.5$  keV found in spectra of several matter-dominated objects may give a clue to resolve the long-standing problem of dark matter. One of the best physically motivated particle candidate able to produce such an extra line is sterile neutrino with the mass of  $\sim 7$  keV. Previous works show that sterile neutrino dark matter with parameters consistent with the new line measurement modestly affects structure formation compared to conventional cold dark matter scenario.

We will present our first results (mainly based on JCAP06(2016)017, arXiv:1604.01341) of contribution of the sterile neutrino dark matter able to produce the observed line at  $\sim 3.5$  keV, to the process of reionization. By incorporating dark matter power spectra for  $\sim 7$  keV sterile neutrinos into semi-analytical 'bubble' model of reionization we obtain that:

- sterile neutrino DM would produce significantly sharper reionization compared to CDM models, impossible to 'imitate' within the CDM scenario under any reasonable choice of our model parameters, providing better consistency with the recent kinetic Sunyaev-Zeldovich data;
- sterile neutrino DM would have a clear tendency of lowering both the redshift of reionization and the electron scattering optical depth (although the difference is still below the existing model uncertainties);
- our results have been qualitatively confirmed by an independent study (Bose et al. 2016, arXiv:1605.03179)

Further dedicated studies of reionization (such as 21 cm measurements or studies of kinetic Sunyaev-Zeldovich effect) will thus be essential for reconstruction of particle candidate responsible the  $\sim 3.5$  keV line.

### GRAVITATIONAL-THERMODYNAMIC CORRELATION (ADAPTED RESONANCES) AND THE MASS SPECTRUM OF THE ELEMENTARY PARTICLES

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We discuss a possibility of gravity-thermodynamic adaptation of the elementary particles to the gravitational background in the vicinity of Earth. It was shown that the adaptation of the parameters matching provided by the generalized center of modulation systems.

### THE ROLE OF CONTINUUM INDUCED SYSTEMATICS IN THE NARROW X-RAY LINES DETECTION PROCEDURE

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Some of recent detections of a narrow emission line at  $\sim 3.5$  keV have been accompanied by subsequent non-detections in the same sources, raising discussion about the actual level of systematic errors. We study the systematics caused by an imperfect knowledge of a continuum model. Our simple theoretical estimate and detailed modelling of simulated spectra allows us to calculate the value of this 'continuum-induced' systematics for a first time. We show that for some objects with well-defined continuum model, such as M31 central part or Draco dwarf spheroidal galaxy, the obtained level of systematics allows to fully reconcile the controversial results claimed previously by different groups of authors. To minimize the effect of 'continuum-induced' systematics, we show that one should reasonably decrease the size of the spectral bin and increase the modelled energy range.

Recent results in searches for 3.5 keV line will also be sketched.

### THE SEARCH GRAVITATIONALLY LENSED QUASARS: THE TECHNIQUE AND FIRST RESULTS

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We present a method for the search of gravitationally lensed quasars. Using this method we selected 15

candidates to gravitational lensed quasars from the Sloan Digital Sky Survey (SDSS) quasar catalog. For the selected objects a deep high-resolution CCD images in r band were obtained. Further processing and analysis of these images revealed for 3 of candidates a signs of lensing galaxy in the close vicinity of components. For these systems we fulfill spectral observations, which confirmed that one of the candidates – SDSS 1442+4055 – is the gravitationally – lensed quasar. Observed angular distance of the lensed components of SDSS 1442+4055 is 2.1 arcsec, the redshift of the quasar-source is  $z=2.575$  whereas the lensing galaxy is located at the redshift of about  $z\sim 0.4$ .

### TENSOR PERTURBATIONS IN COSMOLOGICAL MODELS WITH DYNAMICAL DARK ENERGY: THE CONSTRAINING POWER OF DIFFERENT OBSERVATIONS

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We present the observational constraints on contribution from the tensor mode of perturbations in the models with dynamical dark energy considering the slow-roll inflation. The dark energy is assumed to be a minimally coupled classical scalar field with the barotropic equation of state. The used datasets include Planck-2015 data on CMB anisotropy and lensing, BICEP2/Keck Array data on B-mode polarization, BAO from SDSS and 6dFGS, power spectrum of galaxies from WiggleZ, weak lensing from CFHTLenS and SN Ia data from the JLA compilation. We discuss the importance of different CMB and LSS datasets for constraining the tensor-to-scalar ratio.

### MEASUREMENT OF THE $LY\alpha$ -FOREST TRANSMISSION FROM THE SDSS DR10 QUASAR SPECTRA

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The  $Ly\alpha$  forest in spectra of distant quasars traces the thermal and radiative history of the Universe, as well as the evolution of underlying matter distribution over a wide range of scales and redshifts. It is possible due to relation of the  $Ly\alpha$  opacity of the intergalactic neutral hydrogen  $H_I$  to its density and other physical parameters. As a measure of opacity the value  $F$ , named the transmission and defined as a ratio of observed (transmitted) and emitted fluxes, is used. One of the main problems in these studies is related to determination of emitted flux, i.e. the continuum level in quasar spectra. We present a new method of determination of the continuum level which involves using composite spectra of quasars with similar monochromatic luminosity at  $1450 \text{ \AA}$  ( $l_{1450}$ ) and similar spectral index  $\alpha_\gamma$ ,

within the wavelength range  $1215\text{-}1450 \text{ \AA}$ . For this study we compiled 55 such composite spectra from 13722 medium-resolution quasar spectra from the Sloan Digital Sky Survey Data Release 10. Our method was applied to our sample of 42140 quasar spectra from SDSS DR10 for studying the redshift dependence of the mean transmission and calculating two-point statistics of fluctuations of the transmitted flux in  $Ly\alpha$ -forest (auto-correlation function and flux power spectrum).

### X-RAY EMISSION AND ORIENTATION OF PF GALAXY CLUSTERS

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X-ray counterparts of 35 galaxy clusters from PF catalog of galaxy clusters and groups were found in XMM-Newton archive. 28 clusters (all from ACO catalog) has extended elliptic X-ray haloes appropriate for determination of orientation. Position angles and eccentricities were calculated and compared with cluster orientations optical band.

### ОБ ОСТРОВНЫХ СИСТЕМАХ ВАКУУМНЫХ ПОЛЕЙ ЭЙНШТЕЙНА-МАКСВЕЛЛА

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Обсуждаются свойства вакуумных островных систем, описываемых системой уравнений Эйнштейна-Максвелла. При специальном выборе локального базиса (не обязательно ортогонального) стандартный лагранжиан ОТО может быть представлен в виде, содержащем только скалярные функции и их градиенты. Это позволяет получить уравнения островной системы как уравнения Эйлера-Лагранжа для скалярных функций – инвариантных характеристик изучаемой модели.

Показано, что известное решение Плебанского-Демянского 1976 г. (вращающаяся заряженная однородно ускоренная масса в ОТО) может быть получено введением неортогонального базиса, т.е. без использования комплексной изотропной тетрады. Рассматривается возможность построения вакуумных островных систем в духе Райнича-Уилера, в которых скалярная кривизна пространства-времени модели, как и инварианты свободного электромагнитного поля, тождественно равна нулю.

## ФЕРМИОННОЕ ПОЛЕ В ОСТРОВНЫХ МОДЕЛЯХ С НЕДИАГОНАЛЬНОЙ МЕТРИКОЙ

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При исследовании свойств фермионных полей в ОТО обычно в каждой точке искривленного пространства-времени вводится ортогональный базис, на который проектируются стандартные матрицы Дирака. Ортогональный базис удобен, если пространство-время изучаемой модели описывается диагональной метрикой. Вместе с тем, преобразованием координат в любой конечной области пространства-времени в мет-

рическом тензоре можно убрать только четыре недиагональных вклада, и в общем случае метрика остается недиагональной.

Рассматривается процедура введения спинорной связности в пространствах с недиагональной метрикой. На примере модели островной системы, движущейся с постоянной скоростью  $v$  вдоль оси  $Ox$ , показывается, каким образом, начиная изучение модели с введения метрического тензора, содержащего все 10 компонент, можно прийти к системе уравнений для скалярных функций, зависящих от одной переменной. Обсуждаются свойства модели.

# ASTROPHYSICS

## MCV -"MULTI-COLUMN VIEWER": THE PROGRAM TO VIEW, PLOT AND ANALYSE THE DATA

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The program MCV was initially introduced by Andronov and Baklanov (2004AstSR...5..264A) for realization of the algorithm of the "artificial comparison star" to improve the accuracy of the CCD photometry. The "weights" of the used comparison stars are computed automatically using iterations, and may be used for "mean magnitude - scatter" diagram used for search of new variable stars.

The program has numerous other features, the majority of which are currently absent in modern electronic tables, so complements them.

The most often feature is the automatic scaling of the multi-column (multi-channel) data, with a possibility of making few graphs at the same scale for each channel. If needed, they may be plotted in "all in one mode", like in the electronic tables. The graphs may be plotted in an "astronomical" ("magnitude") mode (the ordinate down) or in an "usual" mode. There is a possibility of removing "bad" objects (single observations in a channel; an observation at a given time in all channels; a channel completely), an unique (among known widely used software) possibilities of: approximation using simultaneously an algebraic polynomial trend and multi-periodic multi-harmonic contributions; periodogram analysis using trigonometric polynomial (multi-harmonic) fit with an algebraic polynomial fit. This is statistically correct, contrary to the widely used "prewhitening", but the "prewhitening" is also available. Also, for the phase curves, there is an additional option of the "symmetrical" trigonometric polynomial fit, which uses the cosine functions only. The error estimates of single measurements may be used. The coefficients, the approximation and their error estimates may be written to files. The image output format is JPG with few pre-defined and user-defined size and other parameters.

The majority of the algorithms were described in 1994OAP.....7...49A and 2003ASPC..292..391A. The program was applied to 1900+ variable stars and is available at <http://soft.softodrom.ru/ap/Multi-Column-View-MCV-p7464>.

## COMPARATIVE ANALYSIS OF APPROXIMATIONS OF BRIGHTNESS EXTREMA OF VARIABLE STARS

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A number of classes of functions are compared, which are used for approximations of extrema of variable stars of different types.

One of the most popular methods for the study of variability of periods variable stars is the analysis of points of "specific" (or "characteristic") events (minimum of brightness for eclipsing stars, maximum for pulsating stars; such events as humps or crossing by the mean phase curve of some fixed value are used less often). This greatly reduces the amount of information that comes down to one parameter and its statistical accuracy. Methods of the period search in the case of small and big changes are considered. Methods for determination the characteristics of extrema are considered. We have created a program written in the VBA programming environment in the Microsoft Excel, which allows to compute local approximation curves at intervals, that cover an extremum in time or phase. We investigated approximations using different basic functions: algebraic polynomial of degree  $s$  in a general form; "Symmetrical" algebraic polynomials using only the even degrees of deviation of the argument from the position of symmetry; "Symmetrical" and "asymmetrical" hyperbolae; "Symmetrical" and "asymmetrical" hyperbolic secant; "Asymptotic parabola"; Gaussians and its modifications using hyperbolic cosine. Symmetric approximation is more effective for eclipses (minimum) of classical eclipsing stars without spots, but, for a determination of the parameters of maximum brightness of pulsating stars, is necessary to consider asymmetry. The statistically optimal approximations for each class of functions and output results are shown in graphics and in a file is printed an optimal approximation (including symmetric) using the criterion of the best estimate of statistical accuracy for the moment (argument) of extremum. In the program, it is realized the batch processing of selected intervals for individual stars. The program was applied to variable stars of different types.

## SUPERNOVA REMNANTS IN THE LATE STAGES OF EVOLUTION

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Properties of supernova remnants (SNRs) in the late stages of evolution are determined mainly by the energy of Supernova explosion, the physical characteristics of the interstellar medium (density, pressure, etc.), where the expansion of the shock wave takes place, as well as the nature of the physical processes occurring at the shock front in the early stages of the evolution of SNR. SNRs in the late stages are almost stationary objects, so the evolution of such objects can be studied by means of statistical methods. In the late stages of their evolution, SNRs are expected to develop dense shells which emit in the optical range and HI 21-cm line. Recently in these ranges a large number of SNRs are identified in nearby galaxies. In this presentation we report the results of modeling of SNR statistics by using the Monte Carlo technique and of their comparison with the observed statistics of real SNRs.

## IMPROVEMENT OF THE PROGRAM “GAUSS2D” FOR FITTING OVERLAPPED IMAGES OF STARS AT THE CCD FRAMES

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We elaborated the program “Gauss2D” implementing the method of least squares (may be run under Windows or Wine/Linux). It makes photometry of the two closely spaced stars on the CCD frame. The program uses the model of the mean background with two overlapped 2D-Gaussian functions. The program uses several methods for minimize of function of some variables – Davidson-Fletcher-Powell, Nelder-Mead, stochastic method of the differential evolution and other. Program allows to process FITS images of several stars to obtain the photometry – either in a manual mode, or in a batch mode. For the identification need of stars, we process the CCD frames using the Czech program MuniWin (version 1.1.30). We need an initial approximation for the algorithm of non-linear optimization. We consider distribution of a relative stars positions of the one series, if it was wrongly selected. The stars, that lie beyond of the  $p\sigma$  interval (where  $p$  – the parameter of the settings,  $\sigma$  – the mean squared deviation) will be processed again using the mean initial parameters of the relative position. The order of the parameters of the test function is: 1 – mean background, 2,3 – maximal intensity of 1 and 2 stars, 4,5;6,7 – coordinates of centers of stars 1 and 2; 8-10 – coefficients of the stellar shape (which is assumed to be the same for both stars). Parameters 8-10 differ not significantly for the stars of one image. So the algorithm finds 10 parameters for one image, then after averaging of the shape parameters – only 7 first. Decrease of number of parameters allows better accuracy of the measurement. There are mode of taking into account nonlinear variations of the Gaussian function within one pixel, and the mode, in which the “hot” pixels are neglected.

## IMPROVEMENT OF THE ALGORITHM FOR DETECTION OF NEW VARIABLE STARS USING CCD PHOTOMETRY

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A distinct advantage of the CCD photometry is that CCD observations allow us to measure brightness of all stars from the field of the telescope simultaneously. Sometimes it happens that in the same field of view besides the main object we may see also other variable stars.

Over the years using CCD photometry different techniques for identifying variable stars were developed, including traditional “blinking” and “scatter” searches.

One of the simplest algorithms is based on the dependency of noise level to mean brightness. The fainter an objects is, the smaller is the signal-to-noise ratio and the noisier is the measurement of the object. According to the statistics, if all stars were constant, the dependence of

standard deviation of brightness vs. mean brightness of an object would have a parabola-like shape. If one star is variable, its standard error is greater than a constant object of the same mean brightness. Particularly, this algorithm is implemented in the C-Munipack software package (<http://c-munipack.sourceforge.net/>), one of the most popular complete solutions for CCD images reduction (“Find variables” dialog).

However, this method does not work in case of relatively big CCD noise, mediocre weather or other reasons, variable stars would appear in a heap of points, and some constant stars with few measurements or big scatter will be located above the curve like they are variables.

In this work we studied the ways to improve this algorithm using well-known relatively simple mathematical and statistical methods. The multiple comparison stars method (Kim, Andronov and Jeon, 2004) is regularly used in our group as implemented in the MCV (Andronov and Baklanov). We applied it to the CCD data using dozens of comparison stars and it allowed us to decrease the influence of the scatter of some particular comparison star on the light curves. We got better dependence of standard deviation vs. mean brightness of stars for the calculated light curves where more variable stars are located above the curve. Later on we compared different modifications of it including criteria for comparison star selection and the quantity of the comparison stars to get it work at the time series obtained using different instruments using any weather conditions.

As the result of this work, the new software was developed. It reads the data exported using C-Munipack and provides the user-friendly interface to obtain and view light curves and periodograms of the stars suspected in variability.

Andronov I.L. Baklanov A.V. 2004, Astron. School Rep. 5, p. 264.  
Kim Y., Andronov I.L. Jeon Y. 2004, Journal of Astronomy and Space Sciences. 21, 3, p. 191-200.

## POPULATION OF RED SUPERGIANTS IN DWARF IRREGULAR GALAXIES

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Red supergiants (RSGs) are the progenitors of type II supernovae. The identification and investigation of RSGs in the Local Group and beyond are extremely important for understanding massive star evolution and mass-loss. Star-forming dwarf irregular (dIrr) galaxies serve as ideal laboratories for investigating physics of red supergiants within the context of different metallicities of host galaxies. Also, RSGs may be used as tracers for abundance determinations and star formation history of dIrrs. We present a systematic survey of RSGs and luminous blue variables (LBVs) in nearby dIrr galaxies with the goal to complete the census of these objects in the Local Group. Using the fact that RSGs and LBVs are bright in mid-infrared colors due to dust, we applied a technique that allows us to select dusty massive stars based on their [3.6] and [4.5] Spitzer photometry (Britavskiy et al. 2014, 2015). We applied our criteria to 7 dIrr galaxies: Pegasus, Phoenix, Sextans A, Sextans B, WLM, IC 10 and IC 1613 selecting 124 point sources, which we observed with the

VLT/FORS2, GTC/OSIRIS and duPont/WFCCD spectrographs in multi-object and long-slit spectroscopy modes.

In total, we observed 124 targets, among which we identified 28 RSGs (21 are new discoveries) and 2 new emission line objects in these galaxies. These new discoveries are statistically significant and this sample increased the number of spectroscopically confirmed RSGs in dIrrs by 50%. Moreover, for the newly identified RSGs we measured the fundamental physical parameters by fitting their observational spectral energy distributions with MARCS stellar atmosphere models.

This work serves as a basis for further investigation of the newly discovered dusty massive stars and their host galaxies.

## NO HOLMBERG EFFECT IN GALAXY PAIRS

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We have studied the Holmberg effect in galaxy pairs from the SDSS DR9, where 61339 galaxies are limited by redshift  $0.02 < z < 0.06$  and by absolute magnitude  $M_r < -20.7$  for central galaxies ( $N=19235$ ) and  $M_r > -20.7$  for faint satellite galaxies ( $N=42104$ ). We have made a morphological classification for  $\sim 700$  galaxies by visual inspection. The rest of our galaxies we binary classify as E – early and L – late types by the random forest method with accuracy 0.91. We used  $\mu$ ,  $M_g$ ,  $M_r$ ,  $M_i$ ,  $M_z$  absolute magnitudes, all corresponding color indices and concentration index C50/C90 to train our method.

We considered four types of galaxy pairs for seeking the Holmberg effect: E-E, E-L, L-E, L-L (first companion of pairs is a central galaxy and second one is a faint satellite galaxy). We did not observe the Holmberg effect in classical meaning because our pairs consist of all morphological types and not only E-E and L-L. However we found a statistically significant excess of pairs with early morphological types in comparison with random expectations.

## THE STUDY OF LINES OF TH II, AC II, PM II IN THE SUPERGIANTS SPECTRA OF THE SMALL MAGELLANIC CLOUD (SMC)

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The study of the chemical composition of SMC – supergiants reveals more efficient r-process compared to our Galaxy. It is shown that heavy elements abundances  $[X/Fe]$  in the atmospheres of SMC – supergiants have excesses after atomic number 56 (Hill, 1989). As example,

is supergiant PMMR144. It was extended the list investigated neutron-capture elements, including some radioactive elements.

## STRONTIUM ABUNDANCES IN COOL DWARF STARS GALACTIC THIN AND THICK DISK

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We revise the strontium abundances in FGK stars with metallicities ranging from  $-1.0 < [Fe/H] < +0.3$ . The observed stars belong to the substructures of the Galaxy thick and thin discs. The observations were conducted using the 1.93 m telescope at Observatoire de Haute-Provence (OHP, France) equipped with the echelle type spectrographs ELODIE and SOPHIE. The results are based on analyses of spectra that have a typical S/N  $\sim 100-300$  and a resolution of 42 000. These estimates were obtained using synthetic spectra using LTE model atmosphere. The comparison of our data with models of chemical evolution was made.

## NUMERICAL METHODS OF DETERMINATION OF ASTROPHYSICAL PARAMETERS. MINIMIZATION OF FUNCTIONS

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We review the main methods for minimization of functions and their implementation in the computer code. The majority of problems of observational data processing and interpretation in astrophysics are the inverse ones. Often these problems are ill-conditioned. Academician A.N.Tihonov is the founder of the theory of solving ill-conditioned problems. The monograph of Goncharskiy A.V., Cherepashchuk A.M., Yagola A.G. "Numerical methods of solving inverse problems of astrophysics" (1978) sets out the basic theory of solving ill-conditioned problems and shows how stable numerical methods are using for interpretation of light curves of eclipsing binary star systems. The monograph of Goncharskiy A.V., Cherepashchuk A.M., Yagola A.G. "On some problems of astrophysics" (1985) significantly expanded the range of astrophysical problems for solution of which applied regularization algorithms. Determination of basic parameters in these astrophysical problems often reduced to minimization of functions of one and several variables.

The main methods of minimization of function  $f(x)$

of one and several variables  $x = (x_1, x_2, \dots, x_n) \in R^n$  are discussed.

There are many iterative methods where at each step of iteration the minimization problem of multidimensional function reduces to the minimum search of function of one variable  $g(\alpha) = f(x^0 + \alpha d)$ . Here



$x^0 = (x_1^0, x_2^0, \dots, x_n^0)$  – given point received on the previous iteration,  $d = (d_1, d_2, \dots, d_n)$  – given vector of minimum search.

The main methods of one-dimensional optimization, and then – multidimensional, are described.

The main algorithms, which are discussed, were implemented in Mathcad. Examples of solution of many extremal problems are presented.

## NUCLEOSYNTHESIS AT MAGNETOROTATIONAL SUPERNOVA EXPLOSION AND GALACTIC CHEMICAL EVOLUTION

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Strong magnetic fields are considered as noticeable pressure component for magnetorotational supernova explosion. At such fields magnetic modification of nuclear structure is shown to shift the nuclear magic numbers in the iron region towards smaller mass numbers approaching titanium [1]. Respectively, maximum of nucleosynthesis products is modified with an enhancement of titanium yield. The results are corroborated with an excess of <sup>44</sup>Ti revealed from the INTEGRAL mission data for young supernova remnants at a field strength ranging up to ten teratesla. Such magnetic impact on nucleosynthesis in galactic chemical evolution is discussed.

[1] V.N. Kondratyev, et al OAP **28**, 168 (2015); EPJ WebConf. **107**, 10006 (2016); **117**, 09007 (2016).

## THE MEAN LIGHT CURVES OF THE MIRA-TYPE STARS IN THE H- AND K-BANDS

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For nine Mira-type stars and one semiregular star the mean light curves have been obtained. The initial values of the brightness (observations) were fitted by a trigonometric polynomial. The parameters and fourier-coefficients (degree of the trigonometric polynomial, amplitude of the brightness, the maximal slope of ascending and descending branch, semiamplitudes and initial epochs of the brightness maximum (minimum magnitude), etc. The mean light curves of the investigated stars are symmetric in the near infrared region (H and K).

## A SEARCH OF FS CMA TYPE HOT STARS SURROUNDED BY CIRCUMSTELLAR DUST

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FS CMa type hot stars surrounded by circumstellar dust has both photometric and spectroscopic signatures. Photometrically it manifests itself by a large infrared excess due to radiation of the circumstellar dust. This feature can serve as a selection criterion for finding new candidates in large photometric databases. Based on color-indices of known objects showing the phenomenon, we searched all-sky catalogs which contain optical and near-IR magnitudes. Recent all-sky photometric surveys at optical and infrared wavelengths obtained with a high positional accuracy (such as UCAC4, 2MASS, WISE) allowed searching for all kinds of objects with circumstellar envelopes. Using our experience in identifying hot stars surrounded by circumstellar dust, we continued searching for more candidates to this type of object. In this talk we present spectral energy distributions of newly found 20 candidates and discuss their possible nature as well as photometric criteria for further searches.

## ON THE PROBLEM OF DETERMINING THE SCALE OF OCCURRENCE OF KEY EVENTS IN THE DEVELOPMENT OF STAR SYSTEMS

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Presentation of the evolution of star systems in the form of directed graphs [1] means the calculation of the probabilities of the key events and the times of their occurrence for each stage of their development. This representation reduces the evolution to a discrete process in which the transition from one state to another occurs abruptly. The time between consecutive key events passes depending on the occurring in the star system processes. On the one hand, if the processes that "control" the development of the system will be defined more accurately, then the probabilities of key events can be calculated more accurately. On the other hand, - outlined processes determine the scale of the development time of the star system.

As was shown earlier [2, 3], the calculation of key events of the development of the star system is reduced to

choosing of certain initial mass spectra of the evolving components of the star systems. Defining of realistic physical conditions in the system for each stage of evolution allowed us to obtain a certain set of mass spectra, which allow performing calculations of key events associated with development of stars systems [4]. The general principles for calculating a time scale of the star system to date has not yet been developed.

The paper analyzes the patterns of occurrence of key events in order to develop a common approach for a fundamental algorithm for calculating a total timescale of star systems and its components.

1. Zakhochay V.A. // Astron. Astrophys. Transact., 1996. V. 10. P. 321.
2. Zakhochay V.A // Proc. Crimean Astroph. Observ., T. 2009. 104, № 6. P. 80.
3. Zakhochay V.A. // Proc. GAO in Pulkovo, 2009, № 219, issue 4., P. 105.
4. Zakhochay V.A., Minakov A.A., Shulga V.M. // Proc. of the 10-th Conf. of Gamow's Astron. School, Aug. 23-28, 2010 - Odessa, Ukraine. P. 115.

## РАЗРАБОТКА И ИЗГОТОВЛЕНИЕ МОДУЛЯ АВТОМАТИЧЕСКОГО ПЕРЕКЛЮЧЕНИЯ СВЕТОФИЛЬТРОВ ДЛЯ ТЕЛЕСКОПА ЗТС 702

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В работе представлены результаты разработки блока автоматического управления турелью светофильтров на телескопе ЗТС-702 Астрономической обсерватории Николаевского национального университета имени В.А. Сухомлинского. Телескоп оснащен приемником изучения SBIG CCD ST7, для которого был изготовлен блок светофильтров с ручным переключением. В блоке были установлены 5 стандартных UBVR1 фильтров, в 6-м окне находится прозрачное стекло ПС для работы с интегральным потоком. При длине трубы телескопа (~3м) механический блок переключения фильтров не всегда давал хорошие результаты.

Для упрощения процесса наблюдений нами был изготовлен электронный блок переключения светофильтров и разработана программа управления этим блоком. Блок установлен на телескопе и испытан в рабочем режиме. Угол поворота турели светофильтров кратен 60° с высокой точностью: центр нужного светофильтра стабильно располагается на оптической оси приемника излучения. За время испытаний установки сбоя, например, установки «не того» светофильтра не было.

Модуль управления автоматическим переключением светофильтров, существенно уменьшает потери времени: для установки соседнего светофильтра в рабочее положение нужна всего 1 секунда, а максимальное время для вывода нужного светофильтра в рабочее положение составляет менее 5 секунд. Быстрое переключение светофильтров позволит повысить эффективность использования рабочего времени астрономи-

ческой обсерватории имени Калиненко Николаевского национального университета.

## LIVE DVD "UBUNTU ASTRONOMY 16.04" 64-BIT

*Oleh Malyi*

*Portugal*

The following distributive is designed for the astronomy amateurs that are familiar with OS Ubuntu (Linux) OS. It is free to download and utilize.

It includes different types of programmes: planetariums, obtaining and edition of astronomical images, telescopes' and other equipment's control through the library and the INDI server.

In order to get familiar with the content in Live DVD mode, you only have to download the \*.iso image format and run it with a virtual machine. One can also create an installation DVD or USB flash drive.

The **Cartes du Ciel / Skychart** enables an access to the collection of the sky atlases. This software allows a big range of possibilities to study celestial objects: virtual observatory mode, SAMP protocole support, conversion of text catalogues for a graphical display with the help of the built-in **CatGen**. It also includes a **HNSKY** sky atlas which has a telescope control function through the INDI server. The **Virtual Moon Atlas** is designed for the Moon study and its planetary analogue is aimed for exploring Mercury, Venus and Mars.

If you want to create a robotic observatory, one can use **KStars**, a program which has a big set of necessary tools. **Stellarium**, **Celestia**, **Digital Universe**, **BoPlanet**, **Where Is M13** are the planetariums and interactive night sky maps installed on the DVD.

You can use **Lin guider** and **PHD2** for the autoguiding during astro-photo sessions. The INDI server and equipment drivers' control is operated through indistarter. **wxAstroCapture**, **Audela** and **oaCapture** are used for the Moon and planets shooting, while **CCDciel**, **GoQat**, **OpenSkyImager**, **Audela** and **KStars** are used for taking photos of deep-sky objects.

The digital cameras' support is made through the *libgphoto2* library. It is also used by **Entangle**, a cameras control program and one of the INDI drivers.

The processing of astronomical images is made through **AstroimageJ**, **Siril**, **THELI GUI**, **Lxnstack**, **ImPPG**, **GCX**, **C-Munipack**, **Stackistry**, **Regim**, **MicroObservatoryImage**.

**SAODS9**, **fv FITS Editor**, **APT**, **Aladin**, **nip2** are installed for the \*.FITS analysis and editing.

Concerning the search and exploration of variable stars, there are two programmes installed on the disc: **C-Munipack** and **Vstar**. **Observation Manager** performs a role of an observations' planner.

"UBUNTU ASTRONOMY 16.04" 64-BIT disc is free for download, distribution and use.

Project site: <https://sourceforge.net/projects/ubuntu-astronomy-16-04/>

Project Facebook page: <https://www.facebook.com/ubuntuastronomy/>

News: <https://twitter.com/UbuntuAstronomy>

## OBSERVATIONS AND MODELING OF SPECTRAL ENERGY DISTRIBUTION OF YOUNG STARS

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Investigation of young stars is one of the main directions in astrophysics. Firstly, it is related to the fact that these studies allow to learn more about the star, about formation and evolution process of the stars and planets. Astronomers of the different countries carried out that kind of study, however there are still some questions that are not clear, in particular physical characteristics of young nonstable stars and certain details of their evolution.

The aim of this work is definition of physical and geometrical characteristics of stars Ae/Be Herbiga type and proto planetary disks surrounding them based on observation and modeling of spectral energy distribution.

Earlier the young star IRAS 22150+6109 was studied by authors. Observations of the star in the optical region were carried out on the Tian-Shan Astronomical Observatory 1 m telescope (Almaty, Kazakhstan). The analysis of obtained photometric and spectral observations of the star has allowed obtaining new data about star's physical characteristics.

In this work 8 young stars (MWC84, MWC297, MWC314, MWC342, MWC623, MWC930, MWC1080, MWC137) have been chosen as objects of study and their photometric observation was carried out on Tian-Shan Astronomical Observatory. Preliminary results of modeling energy distribution in spectra of the studied stars are obtained.

## 3D NUMERICAL HYDRODYNAMICAL SIMULATIONS OF RADIATION-DRIVEN JET LAUNCHING AND DISAPPEARING OVER LOW/HARD STATE

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In the present research we have calculated 3D numerical hydrodynamical simulations of radiation-driven jet launching and disappearing over low/hard state. The calculations show that the jet launching occurs at the beginning of low/hard state over 10-30 minutes of orbital time. The jet disappearing occurs over shot time-scale (of order of 10-30 minutes of orbital time) on the end of low/hard state. The calculations also show that the temperature near the accretor is increased in 100-200

times over low/hard state relatively high/soft state. In the calculations the mass accretion rate in disc is anticorrelated with temperature near the accretor.

## OPTICAL MONITORING OF NGC4151 DURING 110 YEARS

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We present the historical light curve of NGC 4151 for 1906–2016. The light curve (Oknyanskij and Lyuty, 2007) is primarily based on our published photoelectric data (1968–2007, about 1040 nightly mean measurements) and photographic estimates (mostly Odessa and Moscow plates taken in 1906–1982 (Oknyanskij, 1978, 1983), about 350 measurements). Additionally, we include all data obtained prior to 1968 (de Vaucouleurs and de Vaucouleurs, 1968; Sandage, 1967; Wisniewski and Kleinmann, 1968; Fitch et al., 1967) in total, 19 photoelectric observations from 1958–1967, reduced by us to the same diaphragm aperture as that used in our measurements) as well as photographic data (Pacholczyk et al., 1983) (Harvard and Steward observatories' patrol plates taken in 1910–1968, about 210 measurements).

The light curve includes our new photoelectrical and CCD data obtained during last 10 years at SAI and ShAO as well as other published data. All these data were reduced to an uniform photometric system.

Applying Fourier (CLEAN algorithm) we have found periodic component ~16 years in the 100 years light curve. 40 years ago about the same "period" was firstly revealed from Odessa's photometrical data (Oknyanskij, 1977, 1978). This "period" seen in the light curve was then found independently in the spectral variability and interpreted as a case of the supermassive binary black hole (Bon et al., 2012). We interpret these circles as some accretion dynamic time.

## THE CHANGING-LOOK AGNS MONITORING PROJECT

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“Changing-look” AGNs (CL AGNs) are objects which undergo dramatic variability of their emission line profiles and classification type. They can move from one spectral

class to another within very short time intervals (from weeks to years).

We have begun a project of spectral and photometric multiwavelength (IR to X-ray) monitoring which include the selected set of AGNs known already as the CL AGNs.

We will be using the 2-m Zeiss telescope (ShAO) for optical spectroscopy, the 2.5-m telescope of SAI for IR *JHK* photometry and spectrophotometry, and the small Zeiss-600 and AZT-5 telescopes for *BVRI* photometry.

We are also going to search for new CL AGNs using data from the MASTER project and we can obtain historical light curves for known and newly discovered objects using the MASTER observations.

We are planning to apply for X-ray and UV observations of some CL AGNs with the *Swift*. We show some results of such monitoring of the transient object NGC2617. The main goal of the project is to investigate the possibility of repetition of large changes of spectral type in CL AGNs.

Investigation of these objects will be very informative for understanding the nature of these fast variations and the physics of AGNs.

### THE SPECTRAL VARIABILITY OF HD200775 AT THE LOW ACTIVITY PHASE

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The Herbig Be type star HD 200775 (V380 Cep, MWC 361) is a well-known young spectroscopic binary. The system is in a distance 430 ps from the Sun and illuminates the surrounding molecular gas, closest of the reflection nebula known as NGC7023. In this report we have presented results of spectral observations of the star from June to September 2015 at the Cassegrain focus of 2 m telescope by using echelle spectrometer with resolution at 14000 and S/N relation  $\sim 100$  at the  $H\alpha$  and  $\sim 10$  at  $H\beta$ .

We have obtained 15 pairs suitable for processing spectrograms in spectral range 4700-6700 Å from which have measured radial velocities and equivalent widths of lines  $H\alpha$ ,  $H\beta$ , HeI  $\lambda 5876$  Å, D1, D2 NaI, SiII  $\lambda\lambda 6347, 6371$  ÅÅ, [OI] $\lambda\lambda 6300, 6363$  ÅÅ, and first time discovered in the spectra of the star diffuse interstellar bands (DIBs)  $\lambda\lambda 5780$  and  $5797$  ÅÅ. Our observations mainly are corresponding to minimum phases of the radial velocity curves. Our measurements show that the hydrogen emission lines  $H\alpha$  and  $H\beta$  have minimal values of equivalent widths in with scatter at 20-30% around the mean value. Both of these lines show double peaked structure where the intensity of emission components is variable. We have discovered very high variability in the blue wing of hydrogen emission and in the red wing emission of the  $H\beta$ .

The lines [OI]  $\lambda\lambda 6300, 6363$  ÅÅ has a double peaked structure with variable relative violet to red components intensities V/R. These lines also show a variability structure. The radial velocities of components show the scatter at  $\pm 10$  km/s which measured with error  $\pm 1.5-2$  km/s. The equivalent widths of these lines have more large range of variability. The same character as [OI] lines we have obtained also for DIBs  $\lambda\lambda 5780$  and  $5797$  ÅÅ. It is showed that active processes at the circumstellar environment of the system can be influence of more far parts of the circumstellar disk.

### A SET OF PHENOMENOLOGICAL PARAMETERS FOR THE CATALOGUE OF CHARACTERISTICS OF ECLIPSING BINARY STARS

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Based on the experience of modeling light curves of eclipsing variables of different subtypes, we propose a set of primary and additional phenomenological parameters.

Phenomenological modeling is used for the stars, mainly newly discovered, for which are present only photometric observations without information on temperatures and mass ratio of the components. For the systems with smooth light curves like that of the EB and EW types, the trigonometric polynomial fit of optimal order may be effectively used. For the EA-type systems with abrupt and narrow minima, special shapes are much more effective to get a good approximation. We use the NAV algorithm, which has 7 “linear” parameters describing the mean brightness, the ellipticity, reflection and O’Connell effects, as well as the corrected depth of the primary and secondary minima. Additionally, there are 5 “non-linear” parameters, which describe the eclipse width (suggested to be the same for the primary and secondary minimum in a case of a circular orbit), parameters, describing the shape (generally different for different minima), and the phase shift and possible period correction. This algorithm may be obviously extended to a more general case of variable period. From the corrected eclipse depths, we constrain two more parameters, which describe the ratio of effective brightnesses of the eclipsed parts of the stars, and the “total” characteristic of both eclipses, which is equal to zero, if no eclipses, and unity, if both eclipses are total.

This set of characteristics for our catalog is different from other catalogues mainly by using corrected eclipse depths instead of generally accepted total depths affected by effects of proximity, distortion and brightness asymmetry. The special shapes allow determination of the classical parameters with better accuracy.

The method may be applied for parametrization and classification of variable stars discovered from space and ground-based photometrical surveys.

### THE PERIOD CHANGES CAUSED BY EFFECTS OF MASS TRANSFER AND PRESENCE OF THE THIRD COMPONENTS IN THE ECLIPSING CLOSE BINARY STELLAR SYSTEMS

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We studied 9 eclipsing binary stellar systems of  $\beta$  Lyrae and W UMa types (BF Aur, BX And, SX Aur, KR Cyg, V0388 Cyg, V0382 Cyg, WZ Cyg U Peg, BF Vir) by using the O-C analysis. For this aim we used the collection of minima from BRNO (Brno Regional Network of observers) database of eclipsing variables and we obtained some minima as the result of our analysis of the observations

from AAVSO (American Association of Variable Stars Observers) database and our own observations.

We found the increase or decrease of the period between eclipses in 6 systems. These changes can be caused by mass transfer between components of close stellar systems. For these systems we calculated the rates of the mass transfer. Also, we found periodic changes of the period for 6 systems (in 3 systems both types of changes were superimposed). These changes may be explained by the presence of the third component in the system which makes the close binary system rotating around the common center of mass that lead to delays in moments of eclipses due to the finite speed of light. For these systems we estimated the minimal mass of the possible third components and for one system (BF Vir) we obtained the parameters of its orbit. For O-C curve modelling, we created a computer program by using the programming language Python 3.5. For obtaining the best orbital parameters, this program uses the Levenberg-Marquardt's algorithm, which represents the least squares method for the non-linear model.

For each system, we also corrected the ephemerid according to O-C curves.

#### ABOUT CHEMICAL COMPOSITION OF $\alpha$ Ori ATMOSPHERE

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We have analyzed the contribution of chemical abundances of elements in the atmospheres of supergiant our Galaxy  $\alpha$  Ori – the star of spectral type M1 I-M3 I.

#### THE ELECTRON-NUCLEAR MODEL IN THE DEGENERATE DWARFS THEORY WITH COULOMB INTERACTIONS

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The theory of internal structure of cold degenerate dwarfs was developed by the S.Chandrasekhar in the 40-th years of last century, and is based on the equation of state of ideal relativistic degenerate electron gas, which is in the paramagnetic phase at absolute zero temperature [1, 2]. The general theory of structure of the degenerate dwarfs, which could interpret all properties of dwarfs, should consider other factors, and one of the most important among them is the interparticle interactions.

We have calculated the energy of a two-component homogeneous electron-nuclear model at  $T = 0K$  (the nuclear subsystem is in the crystallized state, the electron subsystem – in the paramagnetic or partial spin-polarized state). The calculation was done within the reference system approach, which previously was developed in theory of metals by one of the authors and adapted for description of relativistic electron subsystem. The detailed calculations

have been made in approximation of two- and three particle correlation functions of the electron subsystem with Coulomb interactions. The energy of model was presented in the form of expansion in series of the fine structure constant. The equation of state for this model is defined by the relativistic parameter, the degree of spin polarization of electron subsystem, the nuclear charge and the type of crystal lattice. It is established that the contribution of the three-particle correlations exceeds the contribution of correlation energy of electron liquid relativistic model. The correction to the equation of state of Coulomb interactions is significant at the large nuclear charge. The influence of the electron-nuclear interactions was considered in the second and third order of perturbation to within  $z^2\alpha_0^{5/2}$ , where  $z$  – the nuclear charge,  $\alpha_0 = e^2/\hbar c$  – the fine structure constant. The four particle correlations are insignificant. Our results refine the equation of state of the electron nuclear model, calculated without taking into account many-particle correlations in [3] for paramagnetic phase.

The resulting equation of state we have used for calculation of structure of the cold massive dwarfs.

1. Chandrasekhar S., *Astrophys. Journ.*, **74**, 81 (1931).
2. Chandrasekhar S., *Mon. Not. Roy. Astron. Soc.*, **95**, 676 (1935).
3. Salpeter E., *Astrophys. Journ.*, **134**, 669 (1961).

#### CROSS SECTIONS OF THE EXCITED HYDROGEN ATOMS PHOTOIONIZATION AND FEATURES OF THE SOLAR RADIATION IN THE CONTINUOUS SPECTRUM

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The problem of calculating of a Solar radiation intensity in the continuous spectrum arises, due to the obtained reliable observable data (see [1-3]) in the visible and near-infrared spectral regions. This problem requires the cross sections calculation of the interaction processes between photons and atmosphere particles. Among this processes the most important are the ionization of the negative ions and excited atoms of hydrogen. Currently the spectral dependence of photoionization cross sections of hydrogen ions is calculated by different authors with an accuracy of 1%. This process makes a major contribution in the region  $\lambda \leq 16400 \text{ \AA}$ . The phenomenon of depression in a continuous spectrum of a solar radiation in the range (6500–8200)  $\text{ \AA}$  was detected by us as we take into account the effects of ionization of hydrogen atoms from the excited states with principal quantum number  $n = 3$ . As it follows from our calculations, the spectral dependence of a Solar radiation in the Balmer jump region ( $\lambda < 3650 \text{ \AA}$ ) can be explained by excited atoms photoionization at the  $n = 2$ . The calculations of photoionization cross sections of hydrogen atoms carried out in stationary states approximation [4] have a non-physical behavior in the doorstep region ( $\lambda \leq n^2\lambda_0$ ,  $\lambda_0 = 4\pi\hbar^3(me^4)^{-1} \cong 911,27 \text{ \AA}$ ). We propose a new approach to the consideration of the non-stationary excited states in which the electron level with the quantum number  $n$  is simulated by a continuous function of the density of states taken in the form of symmet-

rical distribution (Lorentz, Gauss etc) with a half-width adjustable parameter. Thus, in the process of ionization of  $E_n$  participates the energy region which is about a damping parameter. The calculation is based on a Coulomb electron wave functions. In the region  $\lambda \ll \lambda_0$ ,  $n^2$  this cross sections coincide with the sections of work [4].

In a doorstep region the received sections are continuous functions  $\lambda$  with has maximum before doorstep and extend to the region  $\lambda > 8200 \text{ \AA}$ , unlike sections of the work [4]. Using the calculated photoionization cross-sections of hydrogen neutral atoms and its ions from the states with  $n = 2, 3, 4$  and A.Aller atmosphere model, we calculated the spectral radiation intensity of the Solar disk center in the region (3000–10000)  $\text{\AA}$ . The results are consistent with the observed data [2-3], including well description of the spectral dependence both in Balmer jump region, and in the field of depression.

1. Vasil'eva I., Stelmakh O. et al.: 2016, Kinem. Phys. Celest. Bod., V. 14, 1 6., P. 242.
2. Neckel H., Labs D.: 1984, Solar Physics, V. 74, 1 90, P.205.
3. Burlov-Vasil'ev K., Vasil'eva I., Matveev Yu.: 1996, Kinem. Phys. Celest. Bod., V. 12, N 3, P.75.
4. Karzas W., Latter R.: 1961, Ap. JS., V. 6., P. 167.

## CHROMOSPHERIC ACTIVITY OF THE FLARE STAR YZ CMI IN QUIESCENCE ACCORDING TO THE FAST SPECTRAL MONITORING DATA

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Spectral monitoring of the flare star YZ CMi ( $U = 12.9$ ,  $B = 12.7$ ,  $V = 11.1$ ) was carried out on the Zeiss-600 telescope at the Peak Terskol Observatory. We used a low resolution grating spectrograph with spectral resolution of  $\sim 70 \text{ \AA}$  and time resolution from 2 to 30 s. The spectra of the star in the quiescent state show emission in the lines  $H\beta$ ,  $H\gamma$ ,  $CaII H + He$ , as well as in the Balmer continuum with equivalent widths of 10 to 15  $\text{\AA}$ . Variations of the equivalent widths of the order of several percents were detected. The characteristic time of variations is about of one minute. The observed variations indicate the non-stationary activity of the flare star YZ CMi chromosphere in the quiescent state.

## SEARCH AND STUDY OF VARIABLE STARS

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The main direction of the presented work is the systematic observation of the stars to determine the type of the variable. Observations are made at the telescope Zeiss optics-1000 V.G. Fesenkov Astrophysical Institute Tien-Shan Astronomical Observatory (altitude 2750 meters above sea

level). 1000mm diameter mirror, the focal length of 6650 mm system. Used CCD camera Apogee U9000 D9. CCD observations are carried out in bands B, V and R Johnson photometric system. The search is performed mainly in the areas of the Milky Way moderate density.

The images were subjected to photometric processing using specialized software Maxim DL5 and further interpretation of the data.

As a result of this work was set variable type (Cepheid, eclipsing variables, etc.) More than 20 stars [1]. In the period from April 20, 2014 on March 19, 2015 (JD 2456768 – 2457100) observations were four new long-period variable stars: USNO-B1.0 1424-0434223; USNO-B1.0 1426-0444148; USNO-B1.0 1425-0436560; USNO-B1.0 1443-0388041 [2]. The average number of frames received for each star – 14. For these stars have been installed outside the light variations in the strip R:

1. USNO-B1.0 1424-0434223 –  $14.6^m \div 17.3^m$ .
2. USNO-B1.0 1426-0444148 –  $15.6^m \div 18.5^m$ .
3. USNO-B1.0 1425-0436560 –  $14.86^m \div 15.20^m$ .
4. USNO-B1.0 1443-0388041 –  $15.75^m \div 16.00^m$ .

Amplitude from the first two stars was about three magnitudes that can be attributed to their long-period variables such as Mira and confirmed by the identification of objects IRAS catalog.

Variable number 3 is likely a red semiregular variable. Variable number 4 has a significantly lower color index and can be attributed to the semiregular variable type SRD or variables BY Dragon (BY type).

1. A.Kusakin, A.Khruslov, R.Kokumbaeva, I.Reva, *Discovery and study of new variable stars using the ZEISS-1000 telescope of the Tien-Shan astronomical observatory*, Proceedings of the National Academy of the Republic of Kazakhstan, Series of Physical-Mathematical - 2014 - №4 - p.51 -59.
2. A.Kusakin, A.Khruslov, R.Kokumbaeva, I.Reva, *Four new long-period variable stars*, Proceedings of the National Academy of the Republic of Kazakhstan, Series of Physical-Mathematical - 2015 - №5 - p.49 -55.

## СЛЕДСТВИЯ ДВУХАКТОВОЙ ФРАГМЕНТАЦИИ В ПРОТОГАЛАКТИКАХ С ОТСУТСТВУЮЩИМ УГЛОВЫМ МОМЕНТОМ

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В статистической космогонии решаются следующие основные обратные задачи [1-3]: на базе накопленного опыта исследований вырабатывается непротиворечивая (по отношению к динамической, химической и фотометрической эволюции, представлениях об истории звездообразования) гипотеза развития звездной системы. Затем, конструируется соответствующий ей направленный граф, записываются все необходимые для описания соответствующего процесса спектры масс развивающихся компонентов, вычисляются по ним вероятности наступления ключевых событий, на основании которых рассчитываются все их долевые содержания на разные моменты времени. Конечным итогом такой работы является построение эволюционной модели звездной системы, в которой

предсказываются все долевого содержания её составляющих на интересующий момент времени.

Целью данной работы, является решение частной задачи: получить алгоритм расчета статистического процесса, описывающего двухактовую фрагментацию протосистемы, имеющую начальный угловой момент близкий к нулю. В результате анализа двух сценариев развития протогалактики на втором этапе фрагментации, описываемых спектрами масс, характерных для невращающегося (1-й тип) и медленновращающегося (2-й тип) газовых шаров [4], получены условия для образования звездных систем (галактик) двух типов.

В образующихся звездных системах 1-го типа звездный состав ограничен массами карликовых звезд ( $\leq 0.8 M_{\odot}$ ) и ожидается значительное представительство звездных остатков. Повторная фрагментация с такими же свойствами начального спектра масс ведет

к образованию звездных систем, свойства которых аналогичны неправильным галактикам. Они содержат значительную газовую составляющую, конкретное значения которой зависит от числа циклов звездообразования.

В случае запуска 2-го (типа) механизма фрагментации на втором глобальном этапе фрагментации ведет к образованию звездных систем обладающих свойствами спиральных галактик.

1. Захожай В.А. // Изв. КрАО, 2009. Т. 104, № 6. С. 80.
2. Захожай В.А. // Изв. ГАО в Пулкове, 2009. № 219, вып.4. С. 105.
3. Zakhzhaj V.A. // Astron. Astrophys. Transact., 1996. V. 10. P. 321.
4. Zakhzhaj V.A. // Astron. Astrophys. Transact., 1995. V. 6. P. 221.

## SUBSECTION “ASTROINFORMATICA”

### AN INVESTIGATION OF THE FON3 CATALOGUE DATA USING WIELEN METHOD

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The method described by Wielen is very efficient provided the data under comparison are independent quantities. In this case, dispersion of positions or magnitudes differences is equal to the sum of their dispersions, because the index of correlation between the data sets is zero. Using three or more independent catalogues, it is easy to estimate the external accuracy of each of them. For the cross-identification of objects, we have used the search window with a 0.5 arcsec radius. Final dispersions were calculated for every sub-range of magnitudes, for the stars with individual differences of position and magnitude exceeding three standard deviations being rejected. The following catalogues have been used for comparison with the FON3: XPM, PPMXL and UCAC4 in the Northern hemisphere. The dispersion of positions or magnitudes are calculated with the use of about 18 million common stars from these catalogues. The results presented in this work is consistent with analysis of the random errors positions and magnitude that had been described by authors of FON3 catalog.

### THE KINEMATICS RESEARCH OF THE GALAXY USING OF VECTOR SPHERICAL HARMONICS METHOD

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We present the results of comparison kinematic parameters of the Galaxy have obtained using stars proper motion of XPM2, PPMXL and UCAC4 catalogue for two solutions. The first method is the classical Ogorodnikov-Milne model, and second is present the method of Vector Spherical Harmonics. The catalogs data were converted to the galactic coordinate system and divided on intervals width 0.5 B magnitudes. The averaged positions and proper motions of stars have been assigned to the geometric centers each of 1200 HealPix fields.

Based on the Ogorodnikov-Milne linear model, we used the proper motions of stars catalogue for determining the kinematics parameters of Galaxy. Components of the rotation tensor were derived from the solution of the system of equations for population of stars of mixed spectral class and for stars with the different color index for individual magnitude range.

The software which allow obtain values of significant coefficients of the vector spherical functions of the velocity field of stars proper motion has been developed. The analysis and comparison of solutions have been completed.

### THE HISTORY OF THE CREATION OF THE CATALOG OF FON'S PROGRAM

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The idea of Northern Sky Survey project (FON) initiated by MAO NASU was realised within ex-Soviet Unian observatories such as Golosiivo, Zvenigorod, Dushanbe, Abastumani and Kitab using similar astrographes (D/F=40/200/(300)) manufactured by Karl Ceisse. There were nearly 2260 photography plates exhibited (since october 1981 till july 1998), scanned and processed about 2260 plates (during 2008-2015) in Golosiivo observatory. The linear size of the plates were 6x6 degree or 8x8 degree. Digitizing of astronegatives has been carried out by means of Microtek ScanMaker 9800XL TMA and Epson Expression 10000XL scanners, with the scanning mode – 1200 dpi. The Catalog of positions  $\alpha$ ,  $\delta$  and B-magnitudes of stars formation procedure consisted of several separated stages as: the catalog of 60 zone formation, the catalog for circumpolar region, and Northern hemisphere catalog formation in may 2016 (from -4 degree to +90 degree). The catalog contains 19 451 751 stars and galaxies with  $B \leq 16.5^m$  for the epoch of 1988.1. The stars and galaxies coordinate were obtained in the Tycho-2 reference system, and B-value in the photoelectric standards system. The internal accuracy of the catalog for all the objects is  $\sigma_{\alpha\delta} = \pm 0.23''$  and  $\sigma_B = \pm 0.14^m$  (for stars within the range of  $B = 7^m - 14^m$  errors are  $\sigma_{\alpha\delta} = \pm 0.10''$  and  $\sigma_B = \pm 0.07^m$ ) for equatorial coordinates and star B-magnitudes correspondingly. Convergence between the calculated and referenced positions TYCHO-2 is  $\sigma_{\alpha\delta} = \pm 0.06''$  while he convergence with photoelectric stellar B-magnitudes is  $\sigma_B = \pm 0.15^m$ . RMS value coordinate's difference for the formed catalogue and UCAC-4 one is  $\sigma_{\alpha\delta} = \pm 0.30''$  (18 742 932 or 96.36% stars and galaxies were identified).

### ASTROMETRY REDUCTION OF DIGITIZED ASTRONOMICAL PLATES

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This paper discusses issues are related to astrometry reduction of astronomical processed plates.



## DIGITAL VERSION OF THE "SHAJN'S PLAN" PROJECT

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The next step for creating a digital version of catalogues and observations obtained on "Shajn's Plan" is presented in this paper. A large collection of direct images and spectral photoplates (over 1500) was obtained according to academician G.A. Shajn's project, aimed for studying the Galaxy's structure from 1947 to 1965. Some results on cataloguing and scanning negatives were published. Today there is an online access for previewing direct images and editable version of catalogues obtained on "Shajn's Plan". The "Input catalogue" for objects visible on this photoplate collection is presented in this paper.

## BALDONE SCHMIDT (LATVIA) TELESCOPE ASTROPHOTOS ARCHIVE

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The archive of the astrophotos taken with the Baldone Schmidt telescope (80x120x240cm) of the Institute of Astronomy of the University of Latvia (IAU code 069, longitude 24.4041 E, latitude 56.7734 N, altitude 103 m) in the period 1967-2005. The archive contain more than 22000 direct and 2300 spectral photos of various sky regions. Information on the types of photo materials and color filters used, mostly photographed sky fields or objects is given. Description of archive is available in computer readable form at the Institute of Astronomy or partly in publication at *Baltic Astronomy*, Vol. 7, p. 653-668.

## OBTAINING POSITIONS OF ASTEROIDS FROM DIGITIZED PROCESSING OF PHOTOGRAPHIC OBSERVATIONS IN BALDONE OBSERVATORY (CODE 069)

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Digital processing of photographic plates of star fields allows, in addition to the main tasks to carry out a massive search for images of small bodies of the solar system and to determine their coordinates. From the observations of earlier epoch, we can extract information about the loca-

tions of these bodies well before discovering them. Modern approach to processing early photographic observations with new technologies can be an effective instrument for rediscovery of asteroids and correction their orbits. We analyzed the results of observations of clusters in UVBR bands and ultraviolet plates made on the 1.2-m Schmidt telescope of the Observatory of University of Latvia in Baldone (code 069). At the moment, it has identified all images of minor planets with 9.8 - 17.1 stellar magnitude on 70 plates for 1967-1991. The catalog of positions and magnitudes of the searching asteroids was compiled. Among them 10 positions for asteroids which at the time of observation were the earliest of the world's known observations of these asteroids. All asteroids positions were compared with the ephemeris JPI DE431. Analysis was carried out.

## PROGRESS IN WORKING WITH THE U-ASTRONEGATIVES FROM THE 1.2 M SCHMIDT TELESCOPE IN BALDONE

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The University of Latvia's Institute of Astronomy stores a collection of 22 thousand photographic plates taken by the 1.2 m Schmidt telescope located at the Baldone observatory. From this collection, there are 767 astronegatives of 314 sky in the Johnson U-filter. The field of view is 19 square degrees with a plate scale of 72"/mm. Starting in June of 2016, hundreds of U-astronegatives have been scanned on an EPSON EXPRESSION 10000XL scanner in order to find the equatorial coordinates and U-magnitudes of stars and galaxies.

Previously cataloged locations and U-magnitudes of 68,784 stars and galaxies for 12 regions using MEGA programme allows us to predict expected accuracy of the whole observed material. The catalog's accuracy for all of the objects are  $\sigma_{\alpha\delta} = \pm 0.28''$  and  $\sigma_U = \pm 0.20^m$  (for stars  $U = 8^m - 14^m$ , error is  $\pm 0.11''$  and  $\sigma_U = \pm 0.09^m$ ) for equatorial coordinates and star magnitudes respectively. The convergence of coordinates with respect to the coordinates of the reference system Tycho2 is  $\sigma_{\alpha\delta} = \pm 0.06''$ . The conformity with photoelectric Upe-magnitude is  $\sigma_B = \pm 0.13^m$ .

## DIGITAL VERSION OF CATALOGUE I.M.KOPYLOV (1953) AND CONNECTION WITH CRAO PHOTOPLATES ARCHIVE

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We created digital version of I.M.Kopylov catalogue of 731 faint stars with spectral classes O-B that were published in "Izvestiya" CrAO in 1953. The catalog contains information about coordinates, magnitudes and spectral classes of stars in field of Milky Way with the center R.A. =  $1^h 22^m$  Decl. =  $+61^\circ 50'$  (1950). We identified all objects and found coordinates for them from the Tycho-2 and other cata-

logues. The comparison of magnitudes and spectral type with modern catalogs are a represent. We digitizing a directly images and photoplates were obtained with objective prism for this field. For all stars in digital catalogue have a link to original plate images with Aladin sky atlas.

### **PROMOTION OF METEOR ARCHIVAL DATABASES INTO VIRTUAL SPACE**

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In the framework of the creation of the modern effective research tool in the meteor science we investigate the possibilities of promotion of meteor archival databases into virtual space. In particular, we discuss the case of the Kharkiv meteor database. These data were obtained in the 70-ies of the last century with using highly sensitive meteor radar MARS (Meteor Automatic Radar System). The maximum recorded star magnitude is to  $+12^m$ . It is one of the largest radar databases in the world (the third place, about 250 thousand meteor orbits). The first place is occupied by the Canadian radar database with sensitivity of up to  $+8^m$  (more than 3 million meteor orbits). The second place belongs to the New Zealand radar database with sensitivity of up to  $+13^m$  (about 500 thousand meteor orbits). All three databases are not published and not submitted to the international centre of meteor data storage in Slovakia, IMD (The Meteor Data Centre). One of the reasons should be considered the complexity of copyright compliance when transmitting large amounts of data because printing of such amount of orbits on paper is difficult. There are also some other reasons. The work on preparation of the Kharkiv database for integration into the virtual space is being carried out now in Kharkiv National University of Radio Electronics. Cooperation with the holders of meteor databases and virtual observatories including the Ukrainian ones is planned.

### **STARS WITH HIGH PROPER MOTIONS IN THE MODERN CATALOGS OF THE CDS DATABASE**

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Stars with high proper motions, for the most part, are the objects located in the solar neighborhood within 100 parsecs. These stars are important targets for a wide range of astrophysical problems, but the accuracy of the results depends on the completeness of the star sample, and for kinematic studies also depends on the uniform distribution over the celestial sphere. There are two catalogs with fast stars in northern hemisphere, while southern hemisphere contains only scattered lists of such stars. This paper presents the results of analysis of samples of stars with proper motions exceeding 150 mas/year from the modern cata-

logs of astronomical database CDS (PPMXL, SPM4, UCAC4, XPM, APOP, LSPM, Tycho2, URAT1 and WISE). Results of pairwise mutual cross-identification of the samples have shown that modern astrometric catalogs contain a significant number of false identifications of stars with large proper motions, and the total number of stars in the resulting samples is extremely small and is not more than 20% on average.

### **ANALYSIS OF ASTEROID'S OBSERVATIONS IN OPEN PHOTOMETRIC DATABASES**

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Today there are several open photometric databases containing important information for the study of the physical properties of asteroids. These databases are based on the results of various measurements of the different sets of objects. The study of statistical correlations between the various databases could significantly expand the list of asteroids with known physical parameters. We present the results of the comparative analysis of the determination of the albedo, diameters and absolute magnitudes of asteroids of five open sources (AKARI, IRAS, NEOWISE, HORIZONS and Pan-STARRS1). The infrared survey WISE (relatively to asteroids is NEOWISE project) and photometric survey Pan-STARRS1 are the widest databases of the absolute magnitudes and the albedo of asteroids providing information about the 139356 and 248457 objects respectively. There are 73301 commonly detected asteroids for these two surveys. The obtained statistical relationships between the databases based on a common sets of asteroids are presented.

### **UKRVO DATA AND SOFTWARE FOR NEW REDUCTIONS OF PHOTOGRAPHIC OBSERVATIONS OF SELECTED MINOR PLANETS**

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The new reductions of the available photographic plates of UkrVO digital archive containing images of selected minor planets were conducted. Data processing of these plates carried out to check the possibility of obtaining the new positions with high accuracy in the system of Tycho2/UCAC4 reference catalogs. Archives of the Research Institute Nikolaev Astronomical Observatory (NAO) and Main Astronomical Observatory of National Academy of Science (MAO) were used. We have chosen near 60 plates from these archives. Observational epochs of the plates were from 1974 to 1985. Usually, there were

3 exposures in each plate and each plate was scanned 6 times with 1600 dpi resolution. The full identification was conducted and coordinates of all objects were obtained with a usage of different options of astrometric reductions. The inner accuracy of obtained positions is within of 0.03"-0.40". The comparison of the new topocentric positions of minor planets with Horizons ephemeris was made for calculation (O-C) residuals and their RMS. The matching with MPC data is present.

### UKRVO – FEATURES AND COMPARISON OF THE NEW CATALOGUE OF PHOTOGRAPHIC SURVEY OF THE NORTHERN SKY

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UkrVO plate archives contain information obtained at different observatories for a long time. With using data of photographic survey of the northern sky (FON project, from -4° to 90°) in Main Astronomical Observatory of National Academy of Science (MAO) new catalogue of positions and magnitudes was obtained. The catalogue contains coordinates and magnitudes of more than 19 million stars and galaxies from 4<sup>m</sup> to 17<sup>m</sup> for the mean epoch of 1988.2. Comparison with the catalogues UCAC4, PPMX, XPM was carried out. The differences of common stars positions between catalogues are from 0.05"-0.06" for the 9-11<sup>m</sup> stars to 0.30"-0.40" for the 5-7<sup>m</sup> and 15-16<sup>m</sup> stars. The differences of common stars B-magnitudes between catalogues are from 0.05<sup>m</sup>-0.10<sup>m</sup> for the 10-11<sup>m</sup> stars to 0.4<sup>m</sup>-0.5<sup>m</sup> for the 6-7<sup>m</sup> and 15-16<sup>m</sup> stars. The obtained results suggest the advisability of using the new catalogue for improving proper motions of stars within the range of 8<sup>m</sup> - 14<sup>m</sup> magnitudes.

### MTM-500 CRAO DATABASE: NGC 188 - FULL STORY

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We present full database of NGC 188 observations which were received at MTM-500 telescope in CrAO. First image of the old open cluster was obtained with television equipment in 1969. More 200 night of television observations from 1969 to 1997 of NGC 188 were included in our database. This cluster was used for calibration of different objects and fields observations. The catalogue of faint secondary standards in the R color system in the scattered cluster NGC 188 was obtained in CrAO and published in 1985 (1985IzKry..73..122M). In 2007 this catalogue was compared to other data from VizieR (2007IzKry.103..135S). In 2016 we used MTM-500 with CCD for observations NGC 188 and added to our database a new data. The database includes the three parts: observations (date, time, filters, observer); catalogue of objects

(coordinates and magnitudes); images (digitization of old photographic observations and new CCD frames).

### THE CATALOGUE OF OBJECTS IN THE FIELD OF GRB160625B AND AFTERGLOW OBSERVATION

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We observed the field of the Fermi LAT GRB 160625B (*GCN 19580*) with the 0.5-m meniscus-Maksutov MTM-500 telescope in Crimean Astrophysical Observatory from 2016/06 26.863 to 2016/06 26.893 UTC (21.986 to 22.702 hours after the LAT trigger in the b, v, r - bands) and 2016/06 27.859 to 2016/06 27.887 UTC (45.899 to 46.564 hours after the LAT trigger in the r - band and without filter). We observed optical emission at the position given by Swift XRT (*GCN 19585*) and confirm detected a bright, fading and uncatalogued source (*GCN 19588*). We calibrated our observations to the reference stars from NOMAD catalogue using the transformation from NOMAD to MTM-500 instrumental system. The catalogue B, V and R magnitude of objects around the field of GRB 160625B and afterglow magnitudes are present in our report.

### DEVELOPMENT OF VIRTUAL OBSERVATORIES SOFTWARE

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In the last few years international efforts for consolidating of astronomical data sources led to creation of IVOA. The main purpose of this organization became bringing together astronomical observation results of ground and space instruments, providing astronomers with powerful and easy-to-use instruments for accessing collected data. Being part of the international astronomer community CoLiTec Group also participate in the development of this project.

The first step was creating software for storing and publication of CCD-frames. It allows user to archive and search frames by specified parameters. External access to the storage was implemented via its own web interface so it may be accessed via Aladin. It also allows you to receive additional frames from external resources such as the SDSS and 2MASS.

The next step was creation of automatic frames loader in collaboration with Vihorlatskiy observatory. Frames uploaded through the web-interface are moderated and then processing with the OLDAS system. Processed frames are stored in the database from which they are published through SIAP protocol.

Further development of CoLiTec VO project was aimed on creating of the universal system for storing light curves of variable stars, together with a series of frames on which they were received. Based on the existing system of storage frames, brightness measuring store was extends it with cross-references. This allowed user requesting fit, curve or star light measurement get all relevant information.

Our next steps are aimed at creating a system of total frame photometry that will be stored on our and other specified resources. As part of this work we consider improving and extending capabilities of "Atlas of the satellites light curves" that is currently being developed in Odessa Astronomical Observatory. Also in collaboration with this observatory we continue creating software for scanned astronegatives processing and providing user-friendly services for obtained results publication.

### **CRAVO: DATABASE OF DISCOVERIES AND ASTEROID OBSERVATIONS**

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1438 asteroids were discovered in Crimea. The first asteroid was discovered on 1913-03-14 by G.N. Neujmin at the Department of the Pulkovo Observatory in Simeiz. The last asteroid from JPL NASA database was discovered on 2007-08-10 at the Crimean Astrophysical Observatory in Nauchnyj. The total number of discoveries: 152 - Simeiz and 1286 - Nauchnyj. We present a database of discoveries and asteroid observations included in the Crimean Astronomical Virtual Observatory. The database contains asteroid number, name, discoverer's name, date of the discovery and subsequent observations. For asteroids in the database there is a link to original plate images with Aladin sky atlas.

### **PHOTOGRAPHIC OBSERVATIONS OF MAJOR PLANETS AND THEIR MOONS DURING 1961-1990 AT THE MAO NAS OF UKRAINE**

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We present the results of digitizing and processing of archival observations to obtain the astrometric positions and stellar magnitudes of major planets and their satellites. The work has been done within the framework of the national project "Ukrainian Virtual Observatory" on the basis of photographic observations carried out in MAO NASU. The processing of digital images and the astrometric reduction of data was made in the software package created and developed in MAO for the reduction of wide field astrometric negatives. The catalogue includes data of 209 plates with images of Saturn's moons (S2-S9), obtained using 4 telescopes during 92 observational nights in 1961-1990. The stellar catalogue TYCHO2 was used as the reference. The internal positional accuracy is  $\pm 0.09$  –

$\pm 0.22$  arcsec, the photometric accuracy is  $\pm 0.27$  –  $\pm 0.37$  mag. The same procedure is now applying for the processing of photographic observations of Neptune, Uranus, and their moons, obtained in MAO during the same period. Up to date, approximately 80% of the observational material is processed.

### **THE EQUATORIAL COORDINATES AND B-MAGNITUDES OF THE STARS IN THE SOUTHERN HEMISPHERE ZONES BASED ON DIGITIZED ASTRONEGATIVES OF FON PROJECT AT THE ULUGH BEG ASTRONOMICAL INSTITUTE**

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FON (Russian abbreviation of the Northern Sky Survey) were carried out at 6 observatories. The Kitab Observatory (KO) of Ulugh Beg Astronomical Institute (UBAI) of the Uzbek Academy of Sciences (UZAS) was involved to this project from 1981 until 1996. For the observations the Double Astrograph of Zeiss (DAZ, D/F = 40/300, 69"/mm) was used. On the FON project about 2600 photographic plates were exposed. In October, 2015 digitization of these astroplates were started using Expression 10000XL flatbed scanner with the spatial resolution of 1200 dpi and completed in June, 2016. The first stage of the work the processing of the 1900 photographic plates in zones of the southern hemisphere with declination between 0 and -20 degrees. The 1500 plates have already been processed. The equatorial coordinates  $\alpha$ ,  $\delta$  of stars and galaxies were determined in the system of the Tycho2 catalogue and the B-magnitudes in the system of the photoelectric standards. UBAI UzAS, Tashkent (Uzbekistan), ASU, Andijan (Uzbekistan), WHO, Essen (Germany), RI NAO, Nikolaev (Ukraine), MAO NASU, Kyiv (Ukraine) attended on the processing of the digitized images. For the data reduction the MIDAS package and software, developed in the MAO NASU were used. Based on the results of the processing of the astronegatives in the sector of right ascension from 0 hours to 24 hours and declination from 0° to -20° the internal errors of the catalogue were estimated. The errors calculated for all stars are 0.2 arcsec and 0.18 mag respectively.

# RADIOASTRONOMY

## THE CURRENT STATE OF DATA TRANSMISSION CHANNELS FROM PUSHCHINO TO MOSCOW AND PERSPECTIVES

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The work of unique Russian space radio observatory in international space VLBI project "RadioAstron" extended until the end of 2017. Therefore, management and monitoring of communication channels between the tracking station in Pushchino and treatment centers in Moscow for the transmission of scientific and telemetry data is still relevant and necessary. The reliability of communication channels is highly dependent from continuous monitoring and scheduled maintenance of network, server equipment and optical communication lines.

The project plans to connect the new link speed 10 Tbit/s to reduce the transmission time. And we are currently performing the new channel testing and selection of appropriate equipment. The 1 Gbit/s old channel, we plan to use as a backup in the future.

## CONNECTION BETWEEN SHOCK WAVE VELOCITY AND II TYPE RADIO BURSTS VELOCITY

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The substantial arguments of strong connection between shock waves velocity and drift velocity of II type radio bursts in 25-180 MHz range are presented. The studied sample has included 112 proton events that were accompanied with coronal shock waves. To evaluate drift velocity and shock wave velocities there was used original records of dynamic spectra from radio spectrograph in 25-180 MHz range. The velocities of shock waves were evaluated with the power mode model of solar corona density decline.

## TRANSFORM OF DSP-Z DATA FOR THEIR USE WITH VLBI URAN SOFTWARE

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Currently, while conducting research on the decimeter very long bases interferometers (VLBI URAN) is used

specially developed VLBI URAN software. It provides equipment testing, observing, recording of data, evaluation of their quality, characteristics defining of the received signals, correlation processing of signals which were recorded at spaced points, results analysis, archiving. Further development of the instrumental base VLBI URAN is associated with the use of wideband DSP-Z receivers. One of ways to using of these receivers is a conversion of raw DSP-Z data to the format of VLBI URAN software for further processing

One of ways to use these receivers is conversion of raw DSP-Z data to the format of VLBI URAN software for further processing. In this paper we discuss the features of DSP-Z data format and data format of VLBI URAN software. We will consider the principles of signal conversion and preservation of data synchronizing when in use format converting. The paper describes format conversion program and presents its performance capabilities.

## TOOLS AND OBSERVATIONAL METHODS OF LOW-FREQUENCY RADIO RECOMBINATION LINES INVESTIGATIONS

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In the report the tools and methods of observations of radio recombination lines (RRLs) which are carried out at Institute of Radio Astronomy of the National Academy of Sciences of Ukraine using the world's largest decameter radio telescope UTR-2 (arrays "South – North" and "East – West") are described. The low-frequency RRLs can be used as effective means of the low-density partially ionized interstellar medium diagnostic. However, low intensities of the lines and high level of interferences makes such investigations very difficult and impose high requirements to equipment. Observations are carried out with the 4096-channel digital correlometer and new generation digital spectral processors with 8192 spectral channels. Currently, the systematic observations of RRLs have been carried out in the directions of remnants of supernova stars, Galactic plane, nebulas and dust clouds. Experiments aimed to finding the redshifted line of neutral hydrogen HI which arises in the cosmological epochs of reionization in the range 8 – 32 MHz are carried out. The carbon RRLs have been detected in the direction of Cassiopeia A in the broad range of frequencies from 20 to 32 MHz. The carbon RRL, corresponding to the transitions to atomic level with number of 1009 (these corresponds to the Bohr size of atom near 0,1 mm) have been registered.

## PARAMETERS OF THE TRANSIENT SIGNALS DETECTED IN THE DECAMETER SURVEY OF THE NORTHERN SKY

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UTR-2 radio telescope has recently accomplished a survey of the Northern sky. This survey is aimed to find pulsars and transient sources. Studies in such a low-frequency range are very difficult, firstly, due to the high influence of propagating effects. Large dispersion delay allows to determine the dispersion measure (DM) of broadband signals with a small characteristic length very accurately.

Parameters of our survey: DM range is  $0 \div 30$  pc cm<sup>-3</sup>, declination - ( $-10 \div 90$ ) degrees, time resolution is 8 ms. Search is held in a five-beam (or sometimes four-beam) mode with recording of the multiplication, addition and subtraction of signals of the “West-East” and “North-South” antennas. The recorded data volume exceeds 80 terabytes.

Using developed routines for automatic data analysis several hundred individual broadband signals were found. Pulses of known pulsars were excluded from the “candidate list”, the others are processed with a special routine which can optimize all stages of signal searching simultaneously. Currently about 70% of data are processed.

Candidate distributions by galactic latitude (b), dispersion measure, signal to noise ratio (SNR) and dependencies “SNR vs b” in three DM intervals were built. The resulting distributions suggest that most of these signals have a cosmic origin.

The rest of the data are being processed now and we develop new routines for visualization of the data obtained with reference to the equatorial and galactic coordinates.

## HEATING OF ELECTRONS IN SPORADIC-E LAYER BY POWERFUL RADIO WAVE

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The first result of powerful radio wave action on plasma in the lower ionosphere is an electron temperature rise. In the present report possible changes in sporadic-E layer resulted from such an electron temperature rise in the layer are considered. It was supposed that the action was not too strong and too long to change parameters of the neutral atmosphere. It was also regarded that the sporadic-E in question is formed by a vertical shear of neutral zonal wind and is situated below the turbopause level. Hence, its

mean features and irregular structure are mainly controlled by neutral atmospheric turbulence. It is known that an electron temperature rise has to result in the enhancement of ambipolar diffusion that provide increase in the thickness of the layer and decrease in its peak density if the sporadic-E was situated above the turbopause. In the present case, the power radio wave does not change the mean parameters of sporadic-E but can change its irregular structure. To estimate consequence of an electron temperature rise for the sporadic-E irregularities we derived formula for the spectrum of plasma density fluctuations generated by neutral turbulence in the layer that takes condition of enhanced ambipolar diffusion into account. The formula was obtained in the framework of macroscopic description of three-component sporadic-E plasma. It allows us to write corresponding analytic expressions for the mean-square level of relative plasma density fluctuations, and for the radar backscatter cross-section per unit volume. It was shown that the electron temperature rise has to result in a decrease in both the fluctuation level and the backscatter cross-section, and also changes the form of plasma irregularity spectrum. These changes are explained by decreasing in the Obukhov-Corrsin wavenumber of the irregularity spectrum because of increase in the ambipolar diffusion coefficient.

## BROADBAND INTERFERENCE AND URAN RADIO TELESCOPE OBSERVATION

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Radio astronomy observations in the decameter waves severely limited radio interference of various origins. In this range, among interference sources, in the first place are broadcast radio communication station, data transmission systems, various remote sensing system. Workload decameter wavelength range such interference is particularly great in the daytime. This is due to the peculiarities of the ionospheric propagation of radio waves. For this reason, the majority of radio astronomy observations are carried out at night.

Methods of interference suppression in radio astronomy are based on the frequency rejection and spatial filtering of received radio signals. The possibility of using spatial filtering, as a rule, is limited by design features of low-frequency radio telescope antenna arrays. Antenna arrays of radio telescopes URAN are divided into two equal parts. This will allow to use a spatial filter for suppression of galactic noise, but not enough for the interference spatial filtering. Modern radio with programmable digital signal processing significantly expanded the possibility of applying the frequency filtering, which provides suppression of narrowband interference. Not solved the problem remains of broadband noise reduction.

We consider the problem of combating broadband radio interference by the example of the radio telescope URAN-4. During the last years, the interference situation in the radio telescope URAN-4 dramatically worsened. At night there was a noise-like interference is not amenable to frequency filtering. This greatly reduced the effectiveness of observations. The paper discusses a method of reducing

the effect of broadband noise-like interference with radiometric measurements. The basis of this method is the use of an additional omnidirectional antenna and a complex multi-channel coherent receiving equipment.

## RATIO OF STRUCTURE COMPONENTS OF GIANT RADIO SOURCES

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Our previous estimates of physical parameters of galaxies and quasars with steep radio spectrum have showed their great radio luminosity and giant radio structure. Examination of the relations of corresponding monochromatic luminosities at different bands (from decametre to X-ray) allows estimate the comparative contribution of emission of structure components of sources. Using the sample of galaxies and quasars with steep radio spectrum from the UTR-2 catalogue we determine the contribution of emission of extensive radio lobes relatively central region, also relatively accretion disk, gas-dust torus, crown of accretion disk of given source. The particular interest has the relation of monochromatic luminosities of objects at near-infrared and X-ray bands, which corresponds to contribution of emission of gas-dust torus relatively emission of crown of accretion disk. The derived estimates of contribution of emission of components of giant sources reveal evolution effects at relations on redshift, linear size, age of examined sources.

## THE STUDY OF THE VARIATIONS OF SATURNIAN LIGHTNING DISPERSION DELAYS

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Ground-based observations of Saturnian lightning became regular after their first successful detection [1] by UTR-2 radio telescope and confirmed by comparison with Cassini's data [2]. The evidence of one of the largest from known storms [3] in December 2010 granted us to explore this phenomenon with unprecedented temporal resolution due to both large number and intensity of discharges and UTR-2 radio telescope accomplishments: high effective area and the upgraded receiver equipment. Complex temporal structure of discharges [3] and dispersion delay characterizing the medium of lightning propagation from the place of burst to observer were discovered and studied.

The data obtained in December 2010 provided study of events duration distribution, evaluation of lightning signals spectrum. Due to both slow data ( $\Delta t = 10$  ms) and waveform data  $\Delta t \approx 15$  ns (1/66 000 000), we could chose different temporal resolution accordingly to S/N (signal/noise) ratio. The paper [2] indicated that the

lightning has a complex structure: millisecond, microsecond, and submillisecond. Present research was strongly directed to the time delay variations though the recording. For signals' dispersion delay we used methods of identification, delay removal and provided further dispersion measure (DM) calculation. As it was shown in [2] for 96 of the most intense lightning signals in the frequency range 19÷25 MHz time delayed signal with an average of 216 microseconds and correspondingly the average value of DM was  $43 \cdot 10^{-6}$  pc/cm<sup>3</sup> [3]. This value is close to the estimated one, but the range of values we received up to  $\pm 20 \cdot 10^{-6}$  pc/cm<sup>3</sup> and standard deviation was  $6 \cdot 10^{-6}$  pc/cm<sup>3</sup>. The histogram distribution of determined DM values can be described with a linear combination of a Gaussian and quadratic laws. But that result was just the first approximation due to the small number of events. Now we can operate much bigger data volume. As a result of slow data ( $\Delta t = 10$  ms) processing we detected more than 20000 bursts. For waveform data processing we expect to have fewer events because the S/N ratio decreases with temporal resolution magnification.

Long-term variations (days) of dispersion measure were received experimentally from electron density of interplanetary medium obtained though interpolation of the open source spaceweather.com data. Due to our estimations the contribution of the interplanetary medium in the resulting dispersion measure from day to day varied by  $\pm 2 \cdot 10^{-6}$  pc/cm<sup>3</sup>. There are two more components making contribution to the total electron density on the way from the storm to observer on the Earth. The variation in Earth and Saturn ionospheres can cause DM variations  $\Delta DM_{\text{Earth}} \approx 4 \cdot 10^{-6}$  pc/cm<sup>3</sup> and  $\Delta DM_{\text{Saturn}} \approx 3.6 \cdot 10^{-6}$  pc/cm<sup>3</sup>. Summarizing all we conclude that total DM deviation should not exceed value of  $10^{-5}$  pc/cm<sup>3</sup>. And we have two times bigger value only for 23 December 2010. And after the analysis of next two days we found even greater variation. For greater precision we need to processed more data with bigger accuracy of DM definition up to  $10^{-7}$  pc/cm<sup>3</sup>.

On the one hand, the fluctuations of dispersion measure from day to day follow from the changeability of planetary ionospheres and interplanetary medium. On the other hand, we should connect fast changes of the electron concentration in planet ionospheres or interplanetary medium bases on the study of spectrum of the DM changes.

1. Konovalenko A. A., Kalinichenko N. N., Rucker H. O., Lecacheux A., Fischer G., Zarka P., Zakharenko V. V., Mylostna K. Y., Griesmeier J.-M., Abranin E. P., Falkovich I. S., Sidorchuk K. M., Kurth W. S., Kaiser M. L., and Gurnett D. A. Earliest recorded ground-based decameter wavelength observations of Saturn's lightning during the giant E-storm detected by Cassini spacecraft in early 2006 // *Icarus*. 2013. Vol. 224, No. 1. P. 14–23. DOI:10.1016/j.icarus.2012.07.024
2. Zakharenko V., Mylostna K., Konovalenko A., Zarka P., Fischer G., Griesmeier J.-M., Litvinenko G., Rucker H., Sidorchuk M., Ryabov B., Vavriv D., Ryabov V., Cecconi B., Coffre A., Denis L., Fabrice C., Pallier L., Schneider J., Kozhyn R., Vinogradov V., Mukha D., Weber R., Shevchenko V., and Nikolaenko V. Ground-based and spacecraft observations of lightning activity on Saturn // *Planet. SpaceSci.* 2012. Vol. 61, No. 1. P. 53–59. DOI:10.1016/j.pss.2011.07.021
3. Mylostna K.Y., Zakharenko V.V., Konovalenko A.A., Fisher G., Zarka P., and Sidorchuk M.A. / Fine time structure of

lightning on Saturn // Радиофизика и радиоастрономия. 2014. Т. 19, № 1. С. 10-19. (in Russian).

## THE DAILY 110 MHZ RADIO WAVE SKY SURVEY: STATISTICAL ANALYSIS OF IMPULSE PHENOMENA FROM OBSERVATION IN 2012-2013

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On the Pushchino Radio Astronomy Observatory of Lebedev Physical Institute by radio telescope BSA (Big Scanning Antenna) in 2012 started daily multi-beam observations at the frequency range 109-112 MHz. The number of frequency bands range from 6 to 32, while the time constants range from 0.1 to 0.0125 sec. This data is an enormous opportunity for both short and long-term monitoring of various classes of radio sources (including radio transients), the Earth's ionosphere, interplanetary and interstellar plasma monitoring, search and monitoring for different classes of radio sources, etc. A specialized database was constructed to facilitate the large amount of observational data ([http://astro.prao.ru/cgi/out\\_img.cgi](http://astro.prao.ru/cgi/out_img.cgi)). We discuss in this paper method of allocation from the database for impulse data of various types. By using the database allocated 83096 individual impulses in declination from +3 to +42 degrees for July 2012 – October 2013 from pulsars, scintillation sources and so one. In result we constructed homogeneous sample suitable for statistical analyzes.

Today we adding in our database observational data from 2013 to 2016. It will be constructed month median data for all observing sky regions. These data will be compared with daily data for monitoring of some radio sources.

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## PROSPECTS OF INTERFEROMETER OBSERVATIONS WITH DSP-Z

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Radio astronomy observations at decameter wavelengths are significantly influenced by radio frequency interferences (RFI) which extend dynamic range of signals and increase technical requirements to telescope equipment. In the first observations with the UTR-2 radio telescope and URAN interferometers analog receivers with a pass-band about 10 kHz were used. It mitigated an impact of RFI but significantly limited a sensitivity of the instruments. Nowadays, a considerable proportion of the radio astronomy receivers are broadband digital devices. The decameter range is not an exception. Thus, the pass-band of modern URAN receivers is equal to 250 kHz. Preliminary filtration decreases significantly RFI level and the dynamical range of the signals at ADC input. It allows reducing ADC bit capacity down to eight bit that restricts a data flow. The radio telescope UTR-2 is now equipped with the DSP-Z digital receivers which allow recording the entire signal band within 0 – 32 MHz. Because of high dynamic range of the input signals a sixteen-bit ADC is

used to guarantee absence of distortions. Such receivers are very flexible and can be used in different programs, including interferometer observation. It should be noted that the width of the applicable band in the interferometer studies is restricted by the dispersion properties of the medium and source-baseline geometry. Besides, there is currently no specialized software for processing of wide-band signals and direct use of those developed for the URAN is impossible because of substantial difference of data formats used in DSP-Z and URAN receivers. A software package have been developed which allows extracting narrow pass-band signals from the data stored by DSP-Z and convert them to the URAN format. We report a strategy of joint using of the wideband receivers and URAN software, and discuss advantages and future prospects of such an approach. Preliminary results of simultaneous observations with the both receivers are presented.

## OBSERVATIONS OF USS RADIO SOURCES AT DECAMETER WAVELENGTHS

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Ultra Steep Spectrum (USS;  $\alpha < -1.30$ ;  $S \sim \nu^\alpha$ ) radio sources have different nature. These can be a classical FR II type radio galaxies, diffuse radio objects associated with close-by clusters or pulsars. The most intriguing class of USS with a poorly known nature is that being unresolved on arcsecond scales. With rare exceptions, these are quite weak radio sources but their steep spectrum allows observing them at decameter wavelengths with threshold sensitivity of the order of ten jansky. The recent upgrade of the URAN receivers has improved the instrument sensitivity to a few Jy, so with its maximum angular resolution of about one arcsec this interferometer network can be used both for studying low-frequency spectra of the USS sources and measuring their angular dimensions. The first observations with the URAN at decameter wavelengths of a sample of the compact USS sources studied earlier at higher frequencies are presented. The main target of the study was detection of the sources emission at decameter wavelengths and determination of their angular characteristics. In addition, such compact objects can be used as calibrators of the interferometer network in case of sufficiently high flux density.

## CATALOG OF VARIABILITY PERIODS EXTRAGALACTIC RADIO SOURCES IN THE CENTIMETER WAVELENGTH RANGE



## ANGULAR STRUCTURE OF FR II RADIO SOURCES 3C169.1 AND 3C263 AT DECAMETER WAVELENGTHS

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On the basis of long-term monitoring data, at 26-meter radio telescope of the University of Michigan (UMRAO) at frequencies 14.5 GHz (1974–2011), 8 GHz (1965–2011), 4.8 GHz (1978–2011) a catalog was made which consists of periods' values of flux density changes of radio emission from 10 extragalactic sources: 3C 273, 3C 120, 3C 345, 3C 446, 3C 454.3, OJ 287, the OT 081, BL Lac, DA 55, CTA 102. For searching the periodicities in curves of the flux density changes, the methods of wavelet analysis and the singular spectrum analysis (Caterpillar-SSA) were applied. This allowed to determine not only the values of periods and their changes over time, but interval of their existence, as well as to decompose the original data into individual oscillations, corresponding to these periods of variability. Data about the main periods of variability allowed to perform forecasting of flux density changes of the studied radio sources, after finishing of UMRAO monitoring.

## THE PHYSICAL CONDITIONS OF THE CENTRAL PART OF ORION A H II REGION BY THE RADIO RECOMBINATION LINES AT 8 AND 13 MM

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Observations of recombination radio lines (RRL) of hydrogen, helium (H, He) and carbon (C) were carried out in several positions of the H II region Orion A with PT22 radio telescope (Pushchino, Russia) at the wave 8 and 13 mm. The information about the ionization structure of the H II region was received. Obtained, the measured helium abundance increases in the directions to "North" and "West" with maximum at angular distances of 100-150", and then decline. The maximum measured relative helium abundance,  $y^+ = n(\text{He}^+)/n(\text{H}^+)$ , is in the range of 9.4 – 11.0 %, therefore the actual its abundance  $n(\text{He})/n(\text{H})$  is  $\geq 9.4(\pm 0.5)\%$ . From where the lower limit of the Primordial helium abundance,  $Y_p \geq 25.19 (\pm 1.15)\%$ , should be expected. This restriction is still not strong enough to assert the excess over  $Y_p$  of the Standard cosmological model ( $\approx 24.8\%$ ), but it admits the existence of unknown light particles. The  $y^+$  behavior and model calculations indicate that  $T_{\text{ef}}$  (effective temperature) of  $\theta^1$  C Ori star is 35000 - 37500 K, corresponding to the star spectral class of  $\approx O6.5V$ , which is important for the calibration of hot O-B stars. Measured electron temperatures ( $T_e$ ) of H II region, taking into account the deviations from the LTE, are in the range of 6600 – 8400 K and are strictly decreasing in direction to the "East". Also information about the turbulent velocities of the ionized gas and its electron density was obtained.

The radio galaxy 3C169.1 and the quasar 3C263, located at nearly the same distance with redshift  $z > 0.6$ , have similar morphological and spectral characteristics. The maps of the sources obtained at decimeter and centimeter wavelengths has shown they are FR II radio sources with steep spectra and approximately equal angular sizes. The very first investigation of the sources structure at decimeter wavelengths is presented in the report. Observations were made using a network of the URAN decimeter interferometers with baselines 42 to 950 km and with maximum angular resolution of arcsec order of magnitude. The models of the image of these sources based on visibility functions measured have been obtained at frequencies of 20 and 25 MHz. They were composed of elliptical components with Gaussian brightness distribution. To facilitate the comparison of these low-frequency models with high-frequency radio images, the latter were converted to the similar models by fitting the Gaussian components to lobes and hot spots selected at the maps. Comparison of the models revealed changes in a structure of the sources studied with frequency decrease and allows to determine spectral characteristics of each component of the models over a wide frequency range.

## SPECIAL FIELD OF RADIO EMISSION OF THE GALAXY

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Brightness temperature of radio emission were measured with the UTR-2 low-frequency radio telescope at frequencies of 14.7, 16.7, 20 and 25 MHz in the following regions of the Galaxy: the Galactic Pole, area of minimum radio brightness and the anticenter. The spectral indices of brightness temperature was determined as for the total radiation, and as for the background Galaxy radiation at decimeter wavelengths in the above mentioned areas. We constructed the brightness temperature spectrum of this regions in combination with data at different other wavelengths.

## ВСПЫШЕЧНАЯ АКТИВНОСТЬ БЛАЗАРА АО 0235+164

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Приведены данные анализа длительного многочастотного мониторинга активного ядра галактики (АЯГ) АО 0235+164 в широком диапазоне длин волн: от радио- до гамма-диапазона. С помощью гармонического анализа данных наблюдений определено наличие орбитального и прецессионного периодов в двойной системе из сверхмассивных черных дыр (СМЧД) – около двух и восьми лет соответственно. Полученные периоды близки к аналогичным периодам в других ярких АЯГ, которые предположительно являются тесными двойными системами из СМЧД и находятся на стадии эволюции близкой к слиянию. В системе АО 0235+164 определены и другие комбинационные периодические составляющие, среди которых можно отметить половинный период прецессии – около 4 лет.

По данным наблюдений развития вспышечных явлений на разных частотах проведен кросскорреляционный анализ и определены задержки смещения времени моментов вспышек, происходящих на разных длинах волн. Подтверждено по аналогии с другими АЯГ эмпирическое соотношение, которому подчиняются задержки изменений потоков с частотой, имеющее вид обратнологарифмической зависимости. Подобная зависимость задержек может указывать на внутренний характер переменности потоков излучения АЯГ на частотах сантиметрового диапазона и выше. Это, также, соответствует гипотезе джетовой активности АЯГ, при которой плазменное образование, перемещаясь от истоков выброса, становится оптически тонким последовательно на все более длинных волнах.

Статистические данные указывают на то, что мы наблюдаем яркие представители АЯГ в небольшом количестве по отношению к общему числу массивных эллиптических галактик из-за узкой направленности излучения в таких объектах (как правило менее  $5^\circ$ ) и короткого времени жизни тесных двойных систем из сверхмассивных черных дыр (порядка  $10^4$  лет).

1. A.E. Vol'vach, M.G. Larionov, L.N. Vol'vach // *Astronomy Reports*, 2015, Vol. 59, No. 2, pp. 145–155.
2. V. S. Bychkova, A.E. Vol'vach, N. S. Kardashev // *Astronomy Reports*, 2015, Vol. 59, No. 9, pp. 851–864.

# SUN, SOLAR ACTIVITY AND ASTROBIOLOGY

## STRATIFICATION OF THE PHYSICAL PARAMETERS OF CONVECTION IN THE SOLAR PHOTOSPHERE

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The models for the solar inhomogeneous photosphere at granular (0.5–5.0 Mm), mesogranular (5–12 Mm) and supergranular (20–40 Mm) scales are constructed from the high quality observations on the 70-cm German Vacuum Tower Telescope (Canary Islands, Spain) by the solution of the inverse nonequilibrium radiative transfer problem. Stratification of the vertical velocities and variations of the thermodynamical parameters (temperature, density, pressure) of the photospheric convection is investigated. It is shown that the convective structure of photosphere at granular and mesogranular scales is similar: the inversion of temperature variations takes place at the heights  $h \approx 200$  km; the convective velocity inversion may occur at the same heights; the inversion of relative variations of density is found at the heights  $h \approx 80$  km; the variations of pressure are positive within ascending flows and negative in descending flows. According to this analysis we conclude that mesostructures appear as a part of a broad distribution of granular scales. We found a significant difference between supergranulation and convective structures at smaller scales – the supergranular flows are stable along the whole photosphere and reach much higher layers than the granular ones.

## SETI, ASTROBIOLOGY AND THE SOLUTION OF FERMI PARADOX

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The discovery of a few thousand of exoplanets stimulated the development of astrobiological research and the emergence of a number of assessments, clarifying the known formula by F. Drake. Due to the prevalence of organic compounds in outer space from which organic molecules can be synthesized, the question is reduced to the appearance of planets that are suitable for the formation and evolution of living organisms. Estimates of a number of authors, including our (A.V. Bukalov, 2003) give the average distance to a habitable planet from the Earth equal to 25-50 light years. The second question is the Astro-sociological paradox by Fermi: if civilization has arisen, it will quickly spread in the galaxy, but this is not observed. There are not observed and the so-called artificial “Dyson spheres”. The first and most simple answer is the assumption that other civilizations besides terrestrial do not exist or they are quickly destroy themselves. However, for a sufficiently large of biospheres it is unlikely. Investigation of the dynamics of the terrestrial civilization, while developing the entire Earth, the stabilization of population, development of nanotechnologies and information communications, shows a change of strategy of extensive and expansive development to strategy of intensive

development with a minimum of energy radiation. In addition, there are demographic, genetic (mutation), heat, radiation, and other barriers to the general expansion of human civilization into space. This leads to undetectable of highly developed civilizations. Moreover, they can use to communication and movement such forms of energy and fields, that are unknown for terrestrial civilization, among the 95% accounted for the dark matter and dark energy. The probability of detection of automatic or cyborg probes of another civilization considerably higher than the probability of coming into direct contact with it, or finding and direct observation of such developed civilization.

## STATISTICAL PARAMETERS OF LARGE SUNSPOT ACTIVITY CYCLE IN 12-24

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Integral distribution equivalent diameters of large groups of sunspots observed in the last 140 years are research. On the basis of the corrected projection area of each group by the respective equivalent diameters were determined and then the integral distribution of diameters for different cycles and for different phases of the same cycle built.

It was found that the cumulative distribution index varies in different cycles, and ranges from about 4 to 7. Most of the cycles at maximum cycle rate phase of growth and gradually decreases in magnitude to the end of the cycle. The most anomalous in this respect is the cycle number 18 (1944-1954), when the rate was very low and almost did not change with the phase of the cycle. Also in some other cycles have their own characteristics in the index changes cumulative distribution. Since the value of this indicator is a characteristic of dispersion (dissimilarity in size) of sunspots, it can be concluded that the different cycles of the convective zone can generate a concentrated magnetic fields of active regions in different statistical modes. With this restructuring of the convection zone to a different generation spots mode, despite the considerable thickness of the convective zone (about 200 mm), it comes fairly quickly – for a time of about one year. This feature may be of interest to the MHD theories of solar cyclicity.

## ABOUT QUASI-PERIODIC CHANGES IN SOLAR AND GEOMAGNETIC INDEXES AND THEIR INFLUENCE ON THE DRAG DYNAMICS OF EARTH ARTIFICIAL SATELLITES

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The time-frequency and multicorrelation analysis of the orbital parameter characterizing the drag of satellites on circular and elliptical orbits with different perigees and or-

bit inclinations in the atmosphere of the Earth was being conducted in 23-24 cycles of solar activity. Among the factors influencing braking dynamics of satellites were taken: W – Wolf numbers; Sp – the total area of sunspot groups of the northern and southern hemispheres of the Sun, F10.7 – the solar radio flux at 10,7 cm; E – electron flux with energies more than 0,6 MeV и 2 MeV; planetary, high latitude and middle latitude geomagnetic index Ap. In the atmospheric drag dynamics of satellites, the following periods were detected: 6-year, 2.1-year, annual, semi-annual, 27-days, 13- and 11-days. Similar periods are identified in indexes of solar and geomagnetic activity. Dependence of the periods of satellites drag on extremes of solar activities and space weather conditions was conducted.

### THE INFLUENCE OF SOLAR ACTIVITY ON THE DYNAMICS OF SPACECRAFTS

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The main problem of research the behavior of artificial satellites of the Earth and anthropogenic bodies is the monitoring of orbital period variations. The main factor of these changes is the effect of space weather (SW). Problematic of this question has stimulated the research conducted in this work.

The selected objects are the uncontrolled satellites from the database Ukrainian optical network stations (UMOS) for 2012–2014. The observational data necessary to solve this problem on the SW are available on the Internet.

As a result a comprehensive research was established relationship between the characteristics of solar activity, their response in the near-Earth environment and fluctuating periods  $P$  of the orbital motion of the artificial satellites. These fluctuations are mainly point to change the density of Earth's atmosphere caused by a solar (index  $F_{10.7}$  and geomagnetic activity ( $\Sigma K_p$  index). The correlation coefficients of  $P$  and  $F_{10.7}$  and of  $P$  and  $\Sigma K_p$  are the evidence of significant connection between them. The obtained results are good indicator of correlation between periods of the satellite and the impact on them as helio- and geoactivity.

### THE ROLE OF PARAMETERS OF SOLAR WIND AND GEOMAGNETIC ACTIVITY IN THE CHANGING OF ORBITAL MOTION OF THE ARTIFICIAL SATELLITES OF THE EARTH

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The solar flares are the most aggressive impact factor on the near-Earth environment. They are a source of corpuscular and X-rays radiation. During solar flares the

flows of high energy particles – protons and electrons, forming the solar wind, are increasing which is a regulator of geomagnetic activity. Changes in solar and geomagnetic activity are the main disturbances of periods of the orbital motion of the artificial satellites.

The paper attempts to estimate the impact of parameters of the solar wind and geomagnetic activity to change in the orbital motion of the artificial satellites of the Earth.

We used: 1) periods of orbital motion of unmanaged satellites in Ukrainian optical station network (UMOS) database for 2012-2014 years;

2) geomagnetic planetary indexes  $K_p$ ;

3) energy spectra of protons and electrons obtained by satellites type GEOS for events within which the orbital periods of the satellites were changed (all helio- and geo-data taken from the Internet).

We obtained, that spectra streams of protons and electrons have no effect softening of the spectrum over time - the time the outbreak. This indicates the possibility of accumulation of particles over the active region (AR), causing further continuous withdrawal of energy from the AR in a flash.

For studied temporal changes of orbital motion periods of the artificial satellites of the Earth were obtained relations between geomagnetic activity and solar wind speed at a given density of total energy of the solar wind and the interplanetary magnetic field intensity. The calculated correlation coefficients have high values.

### PROBLEM OF MISTAKES IN DATABASES, PROCESSING AND INTERPRETATION OF OBSERVATIONS OF THE SUN. II SOLAR FLARES

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The contribution of space-based observations of solar flares in the databases for the past 50 years has increased significantly, almost completely replacing the ground observations. The statistical parameters of the temporal and spatial distribution of solar flares, obtained using ground-based and space-based observations, differ significantly. We investigated the reasons for these differences to be taken into account in the study of flare activity of the Sun in the solar activity cycles 21-24.

### SMALL-SCALE MAGNETIC FIELD DIAGNOSTICS OUTSIDE SUNSPOTS BASED ON DATA FROM SPACE OBSERVATORY HINODE

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We analyze the observations of photospheric magnetic fields carried out by Hinode on January 29, April 8 and May 9, 2015. Separate areas of the photosphere outside sunspots were selected for our analysis where the effective magnetic fields  $B_{\text{eff}}$  measured by Fe I 6301.5 and 6302.5 Å lines were in range of 5–350 Gauss. The spatial resolution of direct observations is about 300 km. On the existence of strong ( $\geq 1$  kG) spatially unresolved magnetic fields indicate such effects: (a)  $B_{\text{eff}}(6301.5) / B_{\text{eff}}(6302.5) = 1.37 \pm 0.12$  instead of 1.00 for a weak homogeneous magnetic field and (b) a characteristic shape of bisectors of  $I \pm V$  profiles for two named lines. The first effect corresponds to the true local strengths  $B_{\text{true}} \approx 1.3\text{--}1.6$  kG, while the second - about 2.3 kG. The qualitative peculiarities of bisector splittings in Fe I 6301.5 line depend on the  $B_{\text{eff}}$  range and may indicate a dominant influence of vertical magnetic field gradient for very weak magnetic fluxes. If we assume that one fluxtube only exists inside enter aperture of the instrument for field range  $B_{\text{eff}} = 20\text{--}40$  G, then true diameters of fluxtubes should be 20–30 km. Possible influence of the brightness contrast and the Zeeman saturation could change this estimation on about 20%. From our results it follows, that even in era of GREGOR telescope (Schmidt et al., 2012), which has 1.5 m aperture and about 80 km resolution on the Sun in red band for direct observations, the smallest magnetic fluxtubes will not resolved spatially.

## ERYTHROCYTES FUNCTIONAL FEATURES IN THE 11-YEAR SOLAR CYCLE

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There had been studied features of rheological blood failures in patients with unstable angina in periods of the high and low solar activity in the 11-year solar cycle. This category of patients is characterized by prethrombotic blood state, although they don't have coronary thrombosis. The research aimed to study compensatory mechanisms which block thrombosis development at the solar activity increase. There had been established that the period of the solar activity increasing in the 11-year solar cycle is characterized by an increase of a blood viscosity, comparing with the period of a low solar activity. Though, erythrocytes functional features in this case are compensatory mechanisms – erythrocyte aggregation

paradoxically reduced and their deformability increases. It is probably connected with the revealed fibrinogen decrease in the period of the high solar activity. We can see that the change of a solar activity is accompanied not only by the progressing of pathologic processes, but also by an activation of adaptive changes in erythrocyte membrane so as to prevent thrombosis.

## THE ROLE OF SHORT-PERIOD GEOMAGNETIC PCL AND PIL PULSATIONS IN THE MIDDLE AND HIGH LATITUDES

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Geomagnetic Pcl and Pil pulsations are contributors to a wave-particle interaction which impacts the energy that the Earth gets from near-earth space. Though, these pulsations can influence a human health also. In Yakutsk the connection between geomagnetic pulsations and the number of emergency calls (EC) from patients with myocardial infarction (MI). Yakutsk is situated in the area of the high (subauroral) latitudes. There was revealed that the season number of EC had several maximums coinciding to a jump of geomagnetic activity which was registered as irregular geomagnetic Pil pulsations of 0,5–4 Hz frequencies. Kleymenova et al. [1] found out that in the low latitudes (Bulgaria) the rise of fatality from MI was connected with stable geomagnetic Pcl pulsations of 0,2–5 Hz, and with melatonin pathway (MI fatality maximum was noticed in winter, minimum – in summer). As we can see, Pil pulsations influence the human's health in the high latitudes as well as Pcl pulsations – in the middle ones.

1. Kleymenova N.G. et al. // *Biophysics*, 2007. Vol. 52, no. 6, p. 1112.

## SMALL SCALE ACTIVE CENTERS IN THE QUIET SOLAR PHOTOSPHERE

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Observations with high spatial resolution (IMaX/SUNRISE and HINODE) showed the presence of jets inside some granules and intergranular layers in a quiet atmosphere of the Sun. But the cause of these phenomena is not found yet. It is unknown whether this is a movement inside of the magnetic loops, or result of magnetic field lines reconnection, or convective collapse.

To study such active centers in a quiet atmosphere of the Sun, we used data of 2D observations of the Sun with high spatial resolution (Dutch DOT telescope) in the line FeI  $\lambda$  5576 Å. The formation depths of the line cover photospheric layers of the solar atmosphere. By solving the inverse radiative transfer problem using observational data, we reconstructed the physical conditions (temperature, pressure, density, radial velocity) in the inhomogeneous solar atmosphere; horizontal velocity field was received using the equations of hydrodynamics.

In the intergranular areas we revealed small-scale compact formations of increased temperature - one side directed and opposite directed photosphere jets. In the jets the substance goes down or goes up and decreases with height. In the lower photosphere layers the speed of the substance is commensurable with the sound speed. We made an analysis of horizontal velocities near active centers (jets). We also constructed models of observed jets in the quiet photosphere of the Sun.

Based on data analysis of digital recording variations of the geomagnetic field induction vector, obtained by magnetic observatories near cities Kiev and Odessa, defined basic periods of their changes in the 24<sup>th</sup> cycle of solar activity. According to data of "Kiev" station we identified periods: 24, 12, 8, 6 hours. According to data of "Odessa" stations the periods are: 24, 12, 8, 6, 5, 4 hours. Temporal characteristics of these periods and their different appearance with presence of magnetic anomalies (Odessa), and in its absence (Kiev) were investigated. The response to impact of changes in space weather was determined by the change in the spectrum of periods and amplitude characteristics. The review of the phase and amplitude characteristics in dynamics evolution of magnetic storms in the two regions was performed. A comparison between periods of the geomagnetic field and the solar cycle indices was made.

**CHARACTER OF APPEARANCE OF THE MAIN PERIODS OF GEOMAGNETIC FIELD VARIATIONS IN THE 24<sup>th</sup> CYCLE OF SOLAR ACTIVITY ACCORDING TO DIGITAL RECORDING IN KIEV AND ODESSA**

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# SOLAR SYSTEM

## MODIFICATION OF GAUSS' METHOD

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The method for determination of orbital elements of celestial bodies was developed by C.F. Gauss as early as at the beginning of the 19th century when the first asteroids were discovered. Up to the present time, this method has been successfully employed for preliminary orbit determination for both circumsolar and near-Earth orbital motion. However, the method presents some limitations in its usage (Samotokhin et al., 2014). In particular, the orbital arc whose length is used for calculations should not be too long as in this case difficulties with solution of some equations may emerge. On the other hand, the orbital arc should not be too short as in this case uncertainties associated with observational errors may occur.

These and other limitations of Gauss' method can be overcome by exploiting capabilities of modern computers. Keplerian elements define the size and shape of the conic (the semi-major axis and eccentricity); a celestial body's position at a given instant of time (the time of perigee passage); the conic section orientation within the orbital plane (the argument of perigee); and, finally, the orbital plane position with regard to the reference coordinate system (the inclination and longitude of the ascending node). At a two-body approximation the orbital plane always intersects the centre of gravity. With this fact the orbital plane position can be independently determined using the method of exhaustive enumeration of all possible values of inclination and longitude of the ascending node (Bondarenko et al., 2014a). All orbital elements can be derived for each pair of elements  $i$  and  $\Omega$  using Gauss' method for determination of orbital elements from two position vectors and instants of time (Escobal, 1970). Based on these orbital elements, it is possible to define a celestial body's position for the current  $i$  and  $\Omega$ . Using the differences between the observed and calculated in such a manner positions (O-C), it is possible to select the inclination and longitude of the ascending node which define the actual position of the orbital plane. It is evident that it is the minimum difference (O-C) that corresponds to the actual position of the orbital plane.

Thus, to ultimately determine the orbital plane using a modified Gauss' method suggested in (Bondarenko et al., 2014a), a priori information on the pattern of the celestial body's motion is required, particularly, whether its motion is direct or retrograde. This requirement is similar to that one for the application of Gauss' method for determination of orbital elements from two position vectors and instants of time (Escobal, 1970).

## «CHURYUMOV UNIFIED NETWORK»: NEW TASKS FOR ASTRONOMICAL OBSERVATORIES TO PROTECT SOCIETY IN THE ERA OF MODERN HYBRID WARS

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We live in time when in different parts of the globe so-called hybrid wars are provoked from the outside, break out and last for years. The hybrid wars cover specific regions having concentrated social, economic, industrial and/or military strategic interests of the parties. It should be emphasized that a number of the leading states have recently successfully created and tested ultra-light drones which use self-destruction function after performing a secret aggressive mission of secret invasion. This allows the aggressor state to mask his aerial aggression as "natural" invasion of fragments of disintegrated nuclei of comets, meteoroids and even as aerospace invasion of space debris items.

The team of authors created and provided the operation of the first version of the "Churyumov Unified Network" for continuous recording of twilight and daytime traces of aerial and aerospace intrusions over Kiev and Kiev district during 2013–2016 years. A total of more than 36,000 copyright photos were obtained, their classification was carried out and the first database was created.

The authors recorded typical space invading meteoroids, comets nucleus fragments and traces of aerial intrusions. Large series of photos of summer fires, explosions of tank farms and even traces of special air operations during periods of hybrid war escalation.

"Churyumov Unified Network" should be supported by all astronomical, meteorological and geodetic observatories, National Academy of Sciences of Ukraine, Academy of Sciences of Higher School, Planetary Society of Ukrainian, educational and other observatories.

## TRACES ON SKY. UNEXPECTED RESULTS OF REGULAR OBSERVATIONS

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If the fireball's track has noticeable angular size, it can be seen even in the daytime. After the flight, bolide

remains a noticeable trace of a dust, dark against the light sky. If such a dust trail illuminated by the rays of the Sun, which had just hid behind the horizon (or even in the moonlight), it is visible as bright lanes in the night sky or in twilight. That's why we call it the twilight bolides. Usually, astronomical observations using of meteor patrols, carried out at night after the evening astronomical twilight. But from March 2013 to October 2015, the authors have obtained several thousands of different tracks in the sky over Kiev. Therefore, we have identified a special class of twilight observations of fireballs. We register the traces of invading to atmosphere of meteoroids of natural and artificial origin. At the same time, observe the traces of fireballs at the day-time are also possible. But they are less effective than in the twilight. Night observations of bright meteoric tracks can usually observe some seconds. While traces of the twilight bolides we observed from some minutes up to two hours, before they be scattered by atmospheric currents.

During the short period of our observations (from March 2013 to 2015), was fixed falling at least a dozen fragments of cometary nuclei, at least five of sufficiently large and dozens of smaller fragments of meteoroids.

#### **THE COMPUTATIONAL METHOD OF IDENTIFICATION OBJECT ON THE SERIES OF THE FRAME WITH SUBSTANTIALLY INCOMPLETE EXTERNAL DIRECTORIES**

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Processing results of CCD-frames are represented as measurements that contain coordinates of detected objects. Information of known celestial objects is contained in the star catalogs, in which data is contained in a separate folder for each object.

During identification of the frame's measurement with the star catalog it is necessary to find the pairwise correspondence between the set of measurements formed on the frame and a plurality objects of the star catalog that belong to the same area of the sky that the formed frame. The problem of identification is reduced to the assignment problem, which is solved by the Hungarian method.

But at the moment significantly star catalogs are not complete, and information about many objects is missing. Accordingly, the purpose of the work is to improve the selective opportunities and reduce processing time of the series of frames with substantially incomplete external directories due to the design and analysis of methods for digital image processing.

To provide a solution the following private problems are defined: development the statistical model of the set of positional changes on the series of frames portion of the celestial sphere; development method of estimation of parameters of the position and motion of objects on measurements on the series of frames; development method of decomposition general task of identification astronomical frames with stars catalogs on the totality of

particular tasks; development method of hierarchical identification the measurements of the frame of astronomical telescope with the forms of star catalog; development method of formation internal catalog of fixed objects on a series of the frames; development method of automated determining of the statistical characteristics of the parameter estimates of objects, that fixed on the series of frames.

The computational method of identification object on the series of the frame with substantially incomplete external directories, use in the CoLiTec software for automatically search for asteroids and comets on a series of CCD frames.

#### **THE EFFECT OF MAJOR METEOR STREAMS ON THE TOTAL OZONE IN THE EARTH'S ATMOSPHERE**

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The correlation between the total ozone and activity of major meteor streams, such as the Perseids, Geminids, Leonids and Orionids, has been found using the Total Ozone Mapping

Spectrometer (TOMS) measurements of the global ozone distribution over the periods 1978-1993 and 1996-2001. The autocorrelation analysis of the total ozone (TO) time series for the

period of about 20 years has confirmed the existence of regular changes in the ozone levels at the peaks of meteor shower activity. It has been established that TO decreases after the dates of peak activity of meteor streams (e.g. the Perseids) or during the whole periods of meteor shower activity (e.g. the Geminids, Orionids and Leonids). The analysis of the total ozone distribution (in the Southern and Northern Hemispheres), as well as the local distribution of ozone (over the selected surface area of several hundred square kilometres), was performed during the Leonid meteor shower in 1999. The atmospheric zones for which the ozone distribution pattern can be described as a result of interaction between the meteor shower material and the ozone layer were localised by applying the TOMS data. Such zones correspond to the regions where the highest Leonid activity has been observed. According to the radar observations (conducted in Kazan, Russian Federation), three activity maxima of the 1988 Geminid shower were reported: on the nights of 7<sup>th</sup>, 12<sup>th</sup> and 14<sup>th</sup> December, 1988. The TO decrease was observed on the same dates. Thus, the analysis of the TO changes during the periods of intense meteor showers' activity enables to preliminary assess the maximum overall decline in the total ozone concentration which makes about 5\$~DU\$ over two weeks. From the results obtained it can be inferred that the ozone layer can be used as an indicator of the interaction between the meteoric material and the Earth's atmosphere.



## STUDY OF THE SOLAR ECLIPSE PHENOMENA OF DWARF PLANET PLUTO

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Pluto was discovered in 1930 [1]. In 2006, by the International Astronomical Union's decision it was referred to the class of dwarf planets [2].

The largest satellite of Pluto was discovered in 1978 as a dwarf planet was approaching perihelion at a distance of 29.7 AU. Another 4 satellites was opened to the summer of 2012 [1], [3].

This distant system is not available for qualitative observations from Earth. In July 2015 the spacecraft "New Horizons" approached Pluto at a minimum distance of 12.5 thousand km away from its surface. The presence of the atmosphere at Pluto was confirmed; the chemical composition of the surface and atmosphere was found, the Pluto's system orbit elements was updated. Because of this, quantitative description of the eclipse in the Pluto system becomes possible [4].

Pluto satellites are positioned so that the eclipse is only possible near perihelion and aphelion of the dwarf planet. A series of eclipses in the Pluto-Charon system lasted from February 1985 to October 1990, the following series of eclipses will take place from 2108 to 2112 [1].

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

- 1.[http://www.allplanets.ru/solar\\_sistem/pluto/history\\_Pluto.htm](http://www.allplanets.ru/solar_sistem/pluto/history_Pluto.htm)
- 2.<http://www.iau.org/news/pressreleases/detail/iau0603/>
- 3.<http://galspace.spb.ru/index408.html>
- 4.<http://www.nasa.gov/feature/methane-snow-on-pluto-s-peaks>

## ON A POSSIBLE CONNECTION OF THE CELESTIAL BODIES WITH THE EARTHQUAKES

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If there is an influence of the Moon and the Sun on the occurrence of earthquakes, the physical nature of such influence can only be the gravitational. The gravitational influence is caused by the resultant tidal forces of the Moon and the Sun, but not by their separate actions. Therefore, any connections the Moon and the Sun with earthquakes should look for on parameters of the resultant tidal force (size, direction, temporal and spatial changes, etc.). The influence of the Moon and Sun on the

occurrence of earthquakes can be seen as a trigger for the release of energy in the hypocenter accumulated by independent underground processes.

There were calculated tidal forces of the Moon  $F_{IM}$  and the Sun  $F_{IS}$  and their resultant force  $F_{MS}$  for different latitudes (from  $90^\circ$  to  $-90^\circ$ ) and for different hypocenter depths (to 700 km).

Tidal force of the Moon sometimes 5 times exceeds the solar one, and sometimes these forces are almost equal

The greatest values of the  $F_{MS}$  take place in the latitudes range of  $\pm 30^\circ$ .

In areas near the poles (higher  $80^\circ$  and lower  $-80^\circ$ ) the resultant force is constantly directed into the ground.

Tidal forces, like their resultant decrease with depth. At depths of 700 km resultant force is by 12% lower than at the surface.

To identify real physical influence of the Sun and the Moon on occurrence of earthquakes it is advisable to analyze parameters of the resultant force in the moments of the events in separate hypocenters.

## AN INFLUENCE OF A NON-GRAVITATIONAL EFFECT ON CHANGE OF SEMI-MAJOR AXES OF KILOMETRE-SIZED MAIN BELT ASTEROIDS

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Numerical calculations of the orbital evolution of asteroids that are included in the databases IRAS and WISE, from 2005 to 2016 were carried out. The calculation results analysis leads to the conclusion that in our days an influence of non-gravitational effects (NGE) of cometary nature becomes apparent in motion of a significant portion (at least 5%) of the main belt asteroids up to 40 km. Such NGE causes the increase of the semi-major axes of orbits of the low-albedo asteroids with respect to the semi-major axes of orbits of bodies with the large albedos. This result is confirmed by distributions of the proper semi-major axes for separate asteroid families. The increase rates of the semi-major axes of orbits of asteroids with diameters of 5- 40 km and albedos  $p_v < 0.1$  can reach  $4-8 \times 10^{-8}$  AU per year.

The physical mechanism of the NGE action should be similar to the NGE in comets. Such conclusion in general is agreed with the available observational data on the axial rotation of the asteroids.

## COMPUTATIONAL METHODS OF DATA PROCESSING FOR DETECTION OF THE OBJECT'S NEAR-ZERO APPARENT MOTION

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The computational methods for detecting of the object's near-zero apparent motion on the series of CCD-frames are developed. Some of methods use the

substitutional decision rules based on the maximum likelihood criterion. The article describes the cases with known, unknown variance of object's position measurements on the CCD-frames and using its external evaluation. Some of methods use XY-wise and coordinate-wise decision rules. They are based on checking the statistical significance of the factor of speed of the object's apparent motion on the series of measurements using the Student's t-test for coordinate-wise decision rules and F-test for XY-wise decision rule. Parameters of observed object's apparent motion should be previously estimated for using all of synthesized decision rules. Also the corresponding interpolated coordinates on the observed frames should be determined.

The methods of natural and statistical modeling of research of quality indication of detection of the object's near-zero apparent motion on the series of CCD-frames are developed. These methods take into account the main features of the formation of the measurement position of object and features of the different methods for detection of the object's near-zero apparent motion on the series of CCD-frames. Measurements of the position of objects included in the internal catalog (IC) with fixed on the frame objects on the series are used as input data for method of natural modeling. Research results are also provided in the article.

The developed computational methods for detecting of the object's near-zero apparent motion were tested and embedded in the plugin for interframe processing of the CoLiTec software package for automated detection of the new and tracking of the known asteroids, comets and faint celestial bodies. Using the CoLiTec software package and proposed embedded computational methods, the comet C/2012 S1 (ISON) – long-period sungrazing comet was discovered, which at the time of discovery was the object with near-zero apparent motion.

## THERMAL ACTIVITY OF THE ENCELADUS

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A lot of heat was found on Saturn's moon Enceladus by means of spacecraft Cassini which significantly exceeds accounts which emerge from the conditions of thermal equilibrium of the solar radiation.

With help of it, there is an inner satellite ocean of water in the southern polar region of the moon which is the source of the geysers.

The aim of our research is the dynamic study of the geysers of Enceladus the substance of which is the main source of E ring of Saturn and calculation of a tidal acceleration and comparison with the results of tidal acceleration of other physically similar satellites of giant planets.

In addition we tried to identify the typical trajectory of particles which fly out from the geysers of the south pole of Enceladus and partially get in E ring of Saturn. For this purpose we determined appropriate vector of speed of release of substance from the geysers of Enceladus based on the integral of energy which links the speed of the

motion on the orbit with chronocentric length and width of the E ring.

Besides we tried to access the possible inclination of orbits particles of the substance which was erupted from the geysers of Enceladus near its south pole based on the integral of moment of impulse. To illustrate the possible trajectories of motion of the particles after getting out from the gravitation field of Enceladus we built a computer model based on the classic task of two bodies. We used the method of spheres of action of planets in the external gravitation field of the Sun.

## SPIN PERIOD AND ATTITUDE OF SATELLITES AND SPACE DEBRIS MEASURED BY USING PHOTOMETRY

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Photometry is an essential method for studying the properties of the motion of satellites and space debris around the center of mass. The Astronomical Observatory of Odessa University used the method of satellites observation, allowing to get the parameters of their orbital motion and rotation around the center of mass. The method is based on two principles: the tracking of the apparent orbital motion of the satellite and receive satellite image against the stars with the greatest possible frequency. Photometry of imaging sequence gives us a light curves of satellite. It should be noted that the timing accuracy of details on the light curve of the satellite is even more important for the interpretation of the recorded brightness variations than the accuracy of the measurement of the satellite's actual brightness; although photometry quality also determines the information content of the data. High-speed photometry makes it possible not only to observe, for example, the presence of "specular flash of shine", but even to adjudicate about the temporal profile of the flashe, and therefore about the indicatrix of the light reflection from corresponding satellite's element. This is a fundamental change in the quality of photometry, and it can, in some cases, "recognize" (find out) of a specularly reflecting surface even when it observed in a one spectral band. Therefore, to measure the brightness and satellite coordinates are important accuracy and lack of systematic errors at registration time exposure image.

As a high-frequency receiver of radiation we used the interlaced CCD camera WATEC-902H2 Sup in focus 50-cm mirror of tracking telescope KT-50. Actual time resolution is about 0.02 seconds. To ensure a reliable and stable recording of measurements time are applied a hardware input of pps from the GPS to video frame.

For 11 years we have assembled an extensive Atlas of the light curves of several hundreds of operational satellites and space debris. This data is used to measure the rotation parameters of interesting space objects around the center of mass. In this paper a method of data analysis and the results obtained for the defunct satellites Envisat, Cbers-2B, Topex

and other are announced. The dynamics of rotation of these bodies is quite different – the rotation period is increasing in some satellites (they are slow down), and others – is reduced (they are accelerate). The spin axis orientation in the space are not fixed. The information on the nature of the rotation can be used for accurate numerical models of the motion of satellites in orbit, as well as for the future Active Debris Removal missions.

## DOUBLE STATION OBSERVATION OF FAINT METEORS IN NIKOLAEV

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

## SPECTRAL PECULIARITIES OF JOVIAN SATELLITES IO AND EUROPE

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Rotation of Io and Europe, major satellites of giant planet Jupiter, around the central planet is synchronous. Thereby it is possible to observe leading and driven hemispheres at the moments of east and west elongations. They constantly are directed along and against the orbital motion respectively. Detailed analysis of observations obtained with spectral resolution  $R=45000$  points to a number of features for surfaces of leading and driven hemispheres of Io and Europe. Leading hemispheres is much brighter and less polluted by "not icy" material.

One explanation of difference between spectra for leading and driven hemispheres of synchronous satellites of giant planets is interaction of satellite surfaces with interplanetary space in powerful magnetosphere of Jupiter. Our preliminary spectral observations clearly indicate the substantial transformation of the top layer of satellite surface soil. Clarification of spectral differences of leading and driven hemispheres using data obtained during different years was done.

Spectral data researching in this work were obtained at 2-meter mirror telescope Zeiss-2000 (peak Terskol Observatory, Northern Caucasus) using high resolution echelle spectrometer in visible wavelength range.

## INTERPRETATION OF PHOTOMETRIC OBSERVATIONS OF THE SPACE OBJECTS

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Large database of photometric light curves of the artificial satellites stored in the Research Institute "Astronomical observatory" of Odessa National University after I.I.Mechnikov as a result of long-term observations was used for solving the problem of interpretation of photometric observations of the artificial satellites. Creating optical-geometrical model of the artificial satellite and simulation of motion conditions of the artificial satellite on orbit allows to calculate its theoretical light curves.

We used the MaxScript program language for simulation that lets as create a model of a satellite of any complexity, simulate the motion conditions of the object on its orbit and the parameters of its motion around the center of mass. This methodology is represented by the example of the artificial satellites, which are moved in unmanaged mode (Topex / Poseidon, Sich-2, Envisat).

The comparison of the results of our model calculations was conducted with the results of determining the rotation parameters of these satellites by other authors.

## THE COMPUTATIONAL METHOD OF SELECTING THE REFERENCE STARS ON THE DIGITAL IMAGE

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Requirements for accuracy of astronomical observations continue to rise. Coordinates determination of celestial objects is performed by relative method with reference stars. Both methods of selecting the reference stars and for determining the position of objects on digital frames are determine the accuracy of astronomical observations of stars.

To form the set of reference stars it is necessary to perform the set of measurements of the frame and the set of stars catalog that correspond to the investigated region of the celestial sphere. Pairs of these sets are identified by use of identification methods.

Constants plates are formed as based on the identification of pairs the measurement of the frame (star of the catalog). The presence of linear constants plates enough for the identification of pairs, but they are not enough for identification with big field of view. Images of stars in the center of the frame are mainly identified by formed linear constant plates.

Most often, at the final conversion coordinates of the coordinates system of the digital frame to equatorial coordinates cubic model is used. It is formed of constants plates which providing reliable identification and measurement of the position of the whole frame. In its turn for the reliable receiving of cubic constants plates need more pairs. Thus, there is a contradiction between using the cube (at least) model of constants conversion and a small amount of identified pairs in the first stages of identification.

Thus, multistage of increase constant plates with simultaneous increase in their amount used for calculating the steam is performed.

Method of estimation of parameters accuracy of the coordinates estimates of reference stars on the digital frame is developed. The obtained results confirm efficiency and reliability of the developed methods.

The computational method of selecting the reference stars, use in the CoLiTec software for automatically search for asteroids and comets on a series of CCD frames.

#### **A SEARCH FOR SURFACE VARIABILITY ON THE DWAF PLANET MAKEMAKE FROM SPECTROSCOPIC OBSERVATIONS**

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We present new visible and near-IR spectroscopic observations of the dwarf planet Makemake obtained in 2006-2013 at 3.6-m Telescopio Nazionale Galileo (TNG) at La Palma, Spain. For spectral analysis we used different methods: (1) slope calculation; (2) determining shift of the methane bands; (3) spectral modeling. All the spectra show a red spectral slopes between 8%/1000 Å and 11%/1000 Å at 0.55-0.65 μm region which implies either homogeneous surface or a near pole-on orientation. The derived values of spectral slope are in consistence with previously reported values, no secular variations were detected between 2005 and 2013. A small blueshift of methane absorption bands, which is usually associated with dilution of methane in nitrogen, was detected. Spectral model results suggest that Makemake's surface is covered with large methane ice grains (~60%) as well as ethane ice (~30%) and methane irradiation products (~10%).

#### **MODERN CCD OBSERVATIONS OF SELECTED MINOR PLANETS FOR THE CONNECTION OF DYNAMIC AND KINEMATIC COORDINATE SYSTEMS**

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One of method of determining the orientation parameters of the dynamic and kinematic coordinate systems is the use of long-term series of ground-based observations of selected asteroids. It's necessary high precision and uniformly covering the asteroids orbit observations for achievement of the best accuracy of the link parameters. The analysis of the available observations of selected asteroids covering the orbit was made with usage MPC database. The value of the true anomaly in the moment of observation was selected as parameter of orbit covering. It is shown that for a number of asteroids are "windows" is not filled with observations, that taking into account for forming of the observational list for the telescope KT-50 (Mobitel complex). The 1553 positions of the 46 asteroid have been obtained during 2014-2016. The comparison of the calculated positions with ephemeris HORIZONS

NASA JPL were made. The RMS error of the differences (O-C) were less than 0.1 arcsec for both coordinates. The comparison of the obtained results with ground based observations by other astronomical observatories shows high accuracy and uniformity of the Nikolaev observations.

#### **SPECTROPHOTOMETRIC RESEARCHES OF THE NEUTRAL GAS-DUST ATMOSPHERE OF THE COMETS C/2014 Q2 (LOVEJOY) AND C/2013 US10 (CATALINA)**

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The observations and research of the long periodic comets C/2014 Q2 (Lovejoy) and C/2013 US10 (Catalina) by optical spectra with an average resolution ( $\lambda/\Delta\lambda \approx 1200$ ) in the wavelength range  $\lambda = 3600-7700 \text{ \AA}$  are presented. The spectra were obtained in February and December 2015 with the help of the telescope AZT-14 ( $D = 0.48 \text{ m}$ ,  $F = 7.7 \text{ m}$ ) and the spectrograph ASP-9 at the station Astronomical Observatory of Taras Shevchenko National University of Kyiv "Lisnyky". At the time of the observations, the comet C/2014 Q2 was at the heliocentric distance of  $r = 1.32 \text{ AU}$  and the geocentric distance  $\Delta = 1.09 \text{ AU}$ , had the integral magnitude  $T = 5.2^m$ , the elongation angle was S-O-T =  $78^\circ$  and the phase angle - S-T-O =  $47^\circ$ . Comet C/2013 US10, at the time of the observations, was at the heliocentric distance of  $r = 1.08 \text{ AU}$  and the geocentric distance  $\Delta = 1.06 \text{ AU}$ , had the integral magnitude  $T = 6.5^m$ , the elongation angle was S-O-T =  $64^\circ$  and the phase angle - S-T-O =  $55^\circ$ .

On the basis of obtained spectral material was carried the identification of spectral emission bands. Calculated some physical parameters of neutral gas cometary atmosphere and dusty cometary atmosphere. Built distribution of general and reflected energy along the slit of the spectrograph. Calculated flows, the number of molecules, gas productivity and lifetime for basic molecular emissions, relative dust productivity and spectrophotometric gradient.

#### **THE PRECISION ORBIT DETERMINATION OF GEOSTATIONARY SATELLITE «EUTELSAT 13B» BY USING OBSERVATIONS OF THE SIGNAL'S TIME DIFFERENCE OF ARRIVAL**

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Space agencies widely use the classical tone-range method for determination of a satellite position. For this aim the tone-range method insert special signals in telemetry signal of a satellite. The travel time of the special signal from ground station to satellite and back is used for estimation of double distance between the ground

station and the satellite. This method has been successfully used for last several decades. However, the method requires the access to the telemetry signal and this can break the control of a satellite. Therefore, the Passive Correlate Range (PaCoRa) method is proposed in the European Space Agency (ESA). The method allows to determine position of an operational satellite without access to its telemetry signal, by using the measuring of the signal's time difference of arrival (TDOA) from operational satellite at two or more ground stations.

The PaCoRa method is used in Ukraine also. If we have four or more observational stations, we can calculate Cartesian coordinates of a tracking satellite for each point in time by using measuring TDOAs and geometric principles. Ukraine has network of four observational stations which measure TDOAs. They are placed in Kyiv, Mukachevo, Nikolayev and Kharkov. The error of satellite's Cartesian coordinates that are calculated in this way equals to several kilometers. In this work, we consider the method of the precision numerical determination of geostationary satellite orbit «Eutelsat 13B» by using measuring TDOAs. The numerical model of orbital motion takes into account perturbations from gravitational attractions of the Sun and Moon, gravitational attractions of solid-Earth tides, gravitational attractions of oceanic tides, gravitational attractions of the non-spherical Earth, radiation pressure of the Sun, and relativistic perturbation. This approach lets to estimate average orbit parameters of a satellite with an error less than 10 m and the measured satellite position better than 100 m. This result is similar to the precision which declared in ESA for determination of the satellite position by using PaCoRa method.

### PASSIVE CORRELATION RANGING OF A GEOSTATIONARY SATELLITE USING DVB-S PAYLOAD SIGNALS

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Passive correlation ranging (PaCoRa) for geostationary satellites is now considered as an alternate to tone-ranging (<https://artes.esa.int/search/node/PaCoRa>). The PaCoRa method has been employed in the Research Institute «Nikolaev astronomical observatory» since the first experiment in August 2011 with two stations spatially separated on 150 km. The PaCoRa has been considered as an independent method for tracking the future Ukrainian geostationary satellite «Lybid». Now a radio engineering complex (RC) for passive ranging consists of five spatially separated stations of receiving digital satellite television and a data processing center located in Mykolaiv. The stations are located in Kyiv, Kharkiv, Mukacheve, Mykolaiv (Ukraine) and in Ventspils

(Latvia). Each station has identical equipment. The equipment allows making synchronous recording of fragments of the DVB-S signal from the quadrature detector output of a satellite television receiver. The fragments are recorded every second. Synchronization of the stations is performed using GPS receivers. Samples of the complex signal obtained in this way are archived and are sent to the data processing center over the Internet. Here the time differences of arrival (TDOA) for pairs of the stations are determined as a result of correlation processing of received signals. Every second measured values of the TDOA are used for orbit determination (OD) of the satellite.

The results of orbit determination of the geostationary telecommunication satellite «Eutelsat-13B» (13° East) obtained during about four month of observations in 2015 are presented in the report. The TDOA and OD accuracies are also given. Single-measurement error (1 sigma) of the TDOA is equal about 8.7 ns for the all pairs of the stations. Standard deviations and average values of the residuals between the observed TDOA and the TDOA computed using the orbit elements obtained from optical measurements are estimated for the pairs Kharkiv-Mykolaiv and Mukacheve-Mykolaiv. The standard deviations do not exceed 10 ns for the both pairs and the average values are equal +10 ns and -106 ns respectively for Kharkiv-Mykolaiv and Mukacheve-Mykolaiv.

We discuss the residuals between the observed TDOA and estimates of the TDOA that are calculated by fitted models of satellite motion: the SGP4/SDP4 model and the model based on the numerical integration of the equations of motion taking into account the geopotential, and the perturbation from the Moon and the Sun. We note that residuals from the model SGP4/SDP4 have periodic deviations due to the inaccuracy of the SGP4/SDP4 model. As a result, estimation of the standard deviation of the satellite position is about 60 m for the epoch of the SGP4/SDP4 orbit elements. The residuals for the numerical model in the interval of one day do not show low-frequency deviation. In this case, the estimate of the standard deviation of the satellite position is about 12 m for the epoch of the numerical orbit elements.

### SEARCH SMALL BODIES IMAGES IN COLLECTIONS DIGITIZED PHOTOGRAPHIC OBSERVATIONS OF PREVIOUS YEARS

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Photographic observation of the XX century is an important source of information on small bodies of the solar system. The provisions of the early oppositions, photometric evaluation brightness for long periods of time allow refining the orbits of asteroids and identifying various non-stationaries. In international databases for many asteroids are very little observable data for accurate estimates of their geometric and kinematic parameters.

Using standard methods of processing digitized images developed in MAO NAS of Ukraine, analysed data Joint Digital Archives UkrVO to detect asteroids. Modern

approach to re-reduction early observations using new technologies and process measurement provides a sufficiently high accuracy provisions. Analysis of ephemeris calculations with known today about the several hundred small planets with observation data showed some interesting results.

## OBSERVATION OF NEAR EARTH ASTEROIDS WITH USING OF COMBINED METHOD

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Observation of many near earth asteroids (NEAs) especially small diameters (less than 140m) are possible only during close approach with Earth when their magnitude and apparent motion increasing. The combined method of observation is used in RI NAO for observation of NEAs with high apparent motion. Combined method consists in separation of processes of observation of reference stars and NEA and using of the short time delay and integration mode (TDI). The main condition of TDI mode using is the fixing the column of CCD in the direction of NEA motion, for this goal the special device camera rotator was developed and applied. Camera rotator rotates the CCD camera around the optical axis of lens. All observations in RI NAO were carried out with using of KT-50 telescope (D=0.5m, F=3.0m). The telescope equipped with CCD-camera Apogee Alta U9000 (3k3k) and camera rotator. Field of view of the telescope is 0.70.7. Limiting magnitude is 18.5. Since 2008, 5300 positions of 325 NEAs have been obtained on KT-50 telescope. RI NAO has an experience in the follow-up NEA observation and small size and low elongation (with solar elongation less than 45) NEA observation. (O-C) of position are within 1.

## NUMERICAL SIMULATION OF BINARY AND MULTIPLE ASTEROIDS SYSTEM DYNAMICS

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The paper shows a method of constructing the asteroid-centric coordinate system for the study of the evolution of the asteroids orbit satellites. The model includes a central asteroid, its satellite (s), Sun, Moon and eight major planets. Also taken into account the not-sphericity of the attracting body (Troianskyi, 2015) and the pressure of sunlight on the asteroid's satellite based shadow function (Troianskyi and Bazyey, 2015). The model takes into account the mutual attraction between all objects.

To calculate the distance modulus to large objects from the asteroid system, you need to know the coordinates of the asteroid-centric coordinates of the Sun, the Moon and the eight major planets. Initially we borrow heliocentric coordinates of the above objects and DE431 numerical theory (Folkner et al., 2014). Further, the Kepler orbital elements are counting heliocentric

coordinates of the asteroid, and then go to the asteroid-centric reference system.

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

## IS THERE 9-TH PLANET IN OUR SOLAR SYSTEM?

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Brown and Batygin informed on indirect evidence of existence of the ninth planet in Solar System (SS). Some evidence pointing on its possible mass in 10 Earth's mass; its distance from Sun at perihelion can be ~200AU, at aphelion 600-1200AU, and orbital period about 15000 years. Authors suggest that in early SS about 4.5 billion years ago, planet has been pushed out of the field of planets formation near the Sun. But all these conclusions are based on computer calculations of orbits of several known trans-Neptunian objects (TNOs), including Sedna, 2004VN112, 2012VP113, 2010GB174, 2007TG422, 2013RF98. We draw attention to the fact that these 6 TNOs found at perihelion, when their brilliance for terrestrial observers be maximal, and orbital speed was greatest. But just only after 50-100 years, they depart from this convenient location in space to open them. And then for thousands years, these objects will move in remote parts of their orbits. Our estimates show that the actual number of TNO with the same orbits as 6 taken into account in calculations objects should be several orders of magnitude greater. But for the moment they are invisible for terrestrial observer, because they are very far from perihelion point. Therefore, on the basis of purely probabilistic assumptions, it should be very large number of TNOs with very eccentric orbits. Then real results of calculation for the entire ensemble of existing remote objects is strikingly different from the primary. And therefore problem of ninth planet is still on the agenda. Most likely, it is necessary to raise the question of finding the many thousands of TNOs on highly elongated orbits, and very far from terrestrial observer.

## THE BRIGHTNESS ALIGNING OF ASTRONOMICAL IMAGES WITH A USE OF MEDIAN FILTER

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There are strict requirements for the uniform distribution of the brightness for background component of the image on CCD frame during the solving of astronomical

tasks for stars and asteroids with a faint visible radiance on CCD frames. Using of the duty flat-frames for calibration of received images does not always lead to desired results, for example, in the presence of parasitic light.

Computational method of astronomic images brightness aligning has been considered. It is based on the inverse median filtering and implementation of this method for big images. The estimates of the average values and STD of the background pixels brightness on some segments of original and aligned frames were introduced as indicators of the background alignment quality. The analysis of the quality indicators of the background alignment of astronomical images have been done with a help of mentioned method. It showed that average values range for the brightness of the background pixels is reduced by two orders in 5% level from maximum value of histogram. At the same time, this reduction is greater when the size of used window is greater as well.

Besides, the using of aligned images leads to increasing of precision indicators in astrometry and photometry of stars, the quality indicators of asteroids and comets detection.

The mentioned computational method allows raising a SNR and reduces the dynamic range of background substrate in astronomical images.

## ORBITAL RESONANCE IN THE SATURN SYSTEM<sup>10</sup>

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Saturn is sixth from the Sun and second biggest planet in Solar System. Saturn's density smaller than water density and its mass  $5.7 \times 10^{26}$  kg. Semi-major axis 9.6 a.u., eccentricity 0.05, inclination to orbit  $5.5^\circ$ .

The most interesting object is the ring system. First time Galileo saw that in a telescope. Rings made of ice and rock. Its plane lies in equator plane and it's easy to see in a little telescope. Rings A, B, C are singled out. Its apparent to a 25 sm. telescope, also you can see a lot of restricted rings and hollow between them. Besides that we know 62 satellites, 23 regular and 38 irregular satellites used in the work except S/2009 S 1 because after the moment of its discovery there are little researches and Kepler orbit elements are unknown.

The main goal is composition of model of system of regular satellites and rings of Saturn for researching motion of irregular satellites that may be caught asteroids.

Authors made this steps to make it:

- We computed orbital resonances between satellites;
- We computed periods for rings and their possible orbital resonances with regular satellites. Orbital resonance is the phenomenon when relation of periods between two objects is a relation between two little integer numbers.

Authors have checked all possible combinations: 252 pairs among regular satellites, 703 pairs among irregular satellites and 1587 pairs among rings and regular satel-

lites. There are no resonances among irregular satellites. We didn't compute relations between rings and irregular satellites because of relations  $\approx 350:1$  because it contradicts the term for orbital resonance.

Periods of rings were computed with elaborated Kepler's law, because an element of a ring moves like the whole ring. We also squared up that the pale of the ring moves not with the same speed as the middle part, that's why we computed resonances for them too.

Work shows orbital resonances just among rings and regular satellites in Saturn system. All results will be used for next researching of satellites motion.

## RADIO METEORS OBSERVATIONS TECHNIQUES AT RI NAO

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The Solar system is inhabited with large number of celestial bodies. Some of them are well studied, such as planets and vast majority of big asteroids and comets. There is one group of objects which has received little attention. That is meteoroids with related to them meteors. Nowadays enough low-technology high-efficiency radio-technical solutions are appeared which allow to observe meteors daily. At RI NAO three methodologies for meteor observation are developed: single-station method using FM-receiver, correlation method using FM-receiver and Internet resources, and single-station method using low-cost SDR-receiver.

## CHANDLER WOBBLE AMPLITUDE CHANGES AND EXCITATION ANALYSIS

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Our epoch (2010<sup>th</sup>) can be crucial for understanding of the Chandler wobble of the Earth axis, because its amplitude is decreasing now, as in 1930<sup>th</sup>. We filter atmospheric and oceanic effective angular momentum OAM and AAM in the Chandler frequency band using Panteleev filter, then compare this geophysical excitation with the geodetic one, obtained through polar motion (PM) observations inversion and Singular Spectrum Analysis. The regions of the world, where the largest input into Chandler excitation comes from are also mapped. We propose that such processes as El Nino Southern Oscillation ENSO, Atlantic Multidecadal Oscillation AMO, and other modes of climate variability could be coupled with the Chandler wobble amplitude variations.

# PLANETARIUM

## РАЗВИТИЕ АСТРОТУРИЗМА В КАРПАТСКОМ РЕГИОНЕ

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Закарпатье является тем звеном, которое соединяет Украину с Европой. Закарпатская область, как целевой регион Украины, участвует в таких программах трансграничного сотрудничества как «Венгрия-Словакия-Румыния-Украина», «Польша-Беларусь-Украина», благодаря которым в течение 2007-2013 гг. на территории края за счет привлечения международной технической помощи воплощено множество проектов, направленных на содействие экономическому и социальному развитию, на улучшение качества окружающей среды, повышение безопасности границ, поддержка сотрудничества «люди-людям».

В Ужгородском национальном университете завершена работа инновационного трансграничного проекта «r1@NETour – Создание научно-туристического продукта и сетевой инфраструктуры для научного туризма в пограничных регионах Марамуреш и Закарпатье», который выполнялся при финансовой поддержке Европейской Комиссии в рамках программы Инструмента Европейского Добрососедства и Партнерства (ИЕДП) «Венгрия-Словакия-Румыния-Украина 2007-2013». В рамках проекта на базе Ужгородского национального университета установлен мобильный планетарий. Проект длился с сентября 2013 г. по декабрь 2015 г. и выполнялся сетью украинско-румынских партнерских организаций, среди которых: Совет жудеца Марамуреш (г. Бая-Маре, Румыния), Музей минералогии – Планетарий Бая-Маре (Бая-Маре, Румыния), Международная Ассоциация Институций Регионального Развития "МАИРР" (г. Ужгород, Украина), Ужгородский национальный университет, Лаборатория космических исследований (г. Ужгород, Украина).

В то же время местные институции сегодня ведут активную работу по подготовке к новому программному периоду программ ИЕДП на 2014-2020 гг.

Учитывая это, Ужгородский национальный университет выступил инициатором создания в Ужанском национальном природном парке и его окрестностях специального парка «Закарпатский парк темного неба» (англ. Transcarpathian Dark-Sky Park), который был провозглашен 11 июня 2016 г.

Провозглашение такой исключительной заповедной зоны на территории Закарпатской области является чрезвычайно актуальным и будет способствовать ознакомлению как широкой общественности, так и специалистов в области астрономии с проблемами светового загрязнения и охраны окружающей природной среды. Зона парка позволит всем желающим проводить на ее территории астрономические наблюдения в условиях отсутствия светового загрязнения.

В сентябре 2016 г. планируется объединение трех парков: Парка темного неба «Полонины» (Словакия), Парка звездного неба «Бещады» (Польша) и Закарпатского парка темного неба (Украина), в парк темного неба «Восточные Карпаты», который стал бы самым крупным парком в Восточной Европе.

Дальнейшее развитие Закарпатского парка темного неба, сотрудничество с астрономическими учреждениями Украины и парками темного неба соседних европейских стран (Польши, Словакии, Венгрии, Чехии, Румынии и др.) будет способствовать популяризации астрономии среди детей и молодежи, а также развитию нового вида туризма – астротуризма – в Закарпатской области.