Taras Shevchenko National University of Kyiv
Department of Astronomy and Space Physics

24th Young Scientists' Conference on Astronomy and Space Physics

Abstracts

Kyiv, 2017

24th Young Scientists' Conference on Astronomy and Space Physics

April 24 – 29, 2017
Kyiv, Ukraine

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Preface

This year Young Scientists' Conference on Astronomy and Space Physics is held for the twenty fourth time. We all have been looking forward to the annual meeting of astronomers at the Taras Shevchenko National University of Kyiv (KNU). Now it has friendly opened its doors for participants from all over the world.

Young Scientists' Conference has a long history. The first meeting was organized by Faculty of Physics of KNU as a students' conference in 1994. Since 1996 our conference has welcomed young researchers from other universities and scientific institutions. During 1994-2016 participants from Ukraine, Russia, Poland, France, Germany, Spain, Sweden, Libya, Egypt, Japan, Finland, Turkey, China, Slovakia, Armenia, USA, Romania, Iran, Armenia, Georgia, Morocco, South Africa and other countries participated in Young Scientists' Conference.

The conference is aimed at strengthen the position of astronomy and promote space physics research. The lectures and reports presented by the participants traditionally reflect modern trends and actual problems of the science, the sessions facilitate informational exchange about the latest innovations and achievements.

We would like to express our gratitude to the invited lecturers and participants for contributing lectures and reports, and to Prof. V. M. Ivchenko for the help in conference organization.

We are especially grateful to Prof. Viktor Khalack (Université de Moncton, Moncton, Canada) and also the following former students of the Astronomy and Space Physics of KNU whose contribution made it possible to provide personal grants for several participants from Ukraine: Dr. Oleksiy Agapitov (University of California, Berkeley, USA), Dmytro Rogozin (Institut für Kernphysik, Karlsruher Institut für Technologie, Karlsruhe, Germany), Kateryna Frantseva (Netherlands Institute for Space Research, Groningen, The Netherlands), Dr. Ievgen Vovk (Max-Planck Institut für Physik, Munich, Germany), Dr. Iurii Babyk (University of Waterloo & Perimeter Institute for Theoretical Physics, Waterloo, Canada), Dr. Iurii Sushch (Centre for Space Research, North-West University, Potchefstroom, South Africa), Dr. Ganna Ivashchenko (KNU, Kyiv, Ukraine).

Maxim Mohorian and
the Local Organizing Committee

PROGRAMME

Monday, April, 24

09.00-13.00 - Registration
13.00-13.30 - Official opening

Section 'Solar Physics & Heliosphere'

13.30-14.15 N. G. Shchukina *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine)* Our understanding of the Sun and the Sun-Earth Connection **(invited)**

14.15-14.30 Andrii Prysiazhnyi *(Astronomical Observatory of Ivan Franko National University of Lviv, Lviv, Ukraine)* Robust method for determination of solar magnetic field strength **(12+3)**

14.30-14.45 Anna Tkachenko, O. K. Cheremnykh, A. N. Kryshtal *(Taras Shevchenko National University of Kyiv; Space Research Institute SSAU-NASU, Kyiv, Ukraine)* The realization and stability of kink mode m=1 in magnetic tube with discontinuous magnetic field **(12+3)**

14.45-15.00 Valeriia Liakh *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Properties of wave propagation along the solar atmosphere above the facular region **(12+3)**

15.00-15.15 Mykola Shevchuk, V. N. Melnik, S. Poedts, V. V. Dorovskyy, J. Magdalenic, A. A. Konovalenko, A. I. Brazhenko, C. Briand, A. V. Frantsuzenko, H. O. Rucker, P. Zarka *(Institute of Radio Astronomy of the National Academy of Sciences of Ukraine, Kharkiv, Ukraine)* The decameter spikes as a tool for the coronal plasma parameters diagnostic **(12+3)**

18.30-21.00 Excursion to the Main Astronomical Observatory of the National Academy of Sciences of Ukraine

Tuesday, April, 25

Section 'Stellar Astrophysics and Interstellar Medium'

09.00-10.00 morning coffee

10.00-10.15 Ihor Kravtsov, V. V. Zakharenko, I. Y. Vasylieva, S. S. Mykhailova, O. M. Ulyanov, A. I. Shevtsova, A. O. Skoryk *(Institute of Radio Astronomy of the National Academy of Sciences of Ukraine, Kharkiv, Ukraine)* Analysis of the transient signals in decameter survey of the Northern sky **(12+3)**

10.15-10.30 Maksim Gorbunov, N. I. Bondar', V. V. Moskvin, A. N. Rublevskiy, A. A. Shlyapnikov *(Crimean Astrophysical Observatory, Nauchny, Republic of Crimea)* "Shajn Plane" Input Catalogue **(12+3)**

10.30-10.45 Agnieszka Gurgul, W. Ogłoza, G. Stachowski, M. Żejmo *(Institute of Physics of Pedagogical University, Kraków, Poland)* Preliminary phase of the polarimetric survey from Mt. Suhora Astronomical Observatory **(12+3)**

10.45-11.00 Michał Żejmo, A. Słowikowska , K. Krzeszowski, P. Reig, D. Blinov *(Janusz Gil Institute of Astronomy University of Zielona Góra, Zielona Góra, Poland)* Optical linear polarization of 74 white dwarfs with the RoboPol polarimeter **(12+3)**

11.00-11.15 Vitalii Breus *(Odessa National Maritime University, Odessa, Ukraine)* Flexible Variable Star Extractor — new software for variable star detection using CCD photometry **(12+3)**

11.15-11.30 Maksym Mohorian, Y. Pavlenko, A. Suarez Mascareno, R. Rebolo, N. Lodieu, V. J. S. Bejar, J. I. Gonzalez Hernandez *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Flare activity of Proxima Cen in the emission Halpha and the resonance Ca II and Na I lines **(12+3)**

11.30-12.00 tea-break

12.00-12.15 Magdalena Szkudlarek, D. Gondek-Rosinska, M. Ansorg, L. Villain *(Janusz Gil Institute of Astronomy University of Zielona Góra, Zielona Góra, Poland)* Differentially Rotating Strange Quark Stars **(12+3)**

12.15-12.30 Vasilii Moskvin, M. A. Gorbunov, A. N. Rublevskiy, A. A. Shlyapnikov *(Crimean Astrophysical Observatory, Nauchny, Republic of Crimea)* Half a century of the observations of the open cluster NGC 188 at telescope MTM-500 **(12+3)**

12.30-12.45 Oleh Buhajenko, B. Ya. Melekh *(Ivan Franko National University of Lviv, Lviv, Ukraine)* Photoionization modelling of planetary nebulae with realistic density distribution using detailed method for diffuse radiation calculation **(12+3)**

12.45-13.00 Ihor Koshmak, B. Ya. Melekh *(Ivan Franko National University of Lviv, Lviv, Ukraine)* The new ionization correction factors, obtained from results of the multicomponent photoionization modeling of low-metallicity H II regions **(12+3)**

13.00-13.05 Sergii Pokhvala *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine)* Short time-scale variability in the spectrum of Eta UMa **(poster)**

13.05-13.10 Volodymyr Vasylenko, A. Simon, E. Pavlenko *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Photometric monitoring of CV stars in Lisnyky in 2017 **(poster)**

13.30-14.30 lunch

14.30-19.00 City tour (walking tour)

Wednesday, April, 26

Section 'Extragalactic Astrophysics & Cosmology'

09.00-10.00 morning coffee

10.00-10.15 Mykhailo Illiashyk, V. S. Akhmetov, P. N. Fedorov, A. B. Velichko *(V.N. Karazin Kharkiv National University, Kharkiv , Ukraine)* The kinematic research of Galaxy using data of PMA catalogue **(12+3)**

10.15-10.30 Andrii Maliuk, I. A. Zinchenko *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* The research of oxygen abundance evolution in massive galaxies **(12+3)**

10.30-10.45 Pavlo Panasyuk, B. Ya. Melekh *(Lviv Physics and Mathematics Lyceum, Lviv, Ukraine)* Influence of the thin shells with high density on the ionization structure of dwarf galaxies with active star formation **(12+3)**

10.45-11.00 Anatoliy Tugay, N. G. Pulatova *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Two-dimentional correlation function for the distribution of isolated galaxies **(12+3)**

11.00-11.15 Iurii Babyk *(University of Waterloo, Perimeter Institute for Theoretical Physics, Waterloo, Canada; Main Astronomical Observatory of the National Academy of Scienced of Ukraine, Kyiv, Ukraine)* Probing the distant cluster of galaxies JKCS 041 ($z = 1.8$) on the $L - T - M$ scaling relations **(12+3)**

11.15-11.30 Olena Torbaniuk, G. Ivashchenko *(Main Astronomical Observatory of the National Academy of Scienced of Ukraine, Kyiv, Ukraine)* The mean transmission of the Lyα-forest from the SDSS DR10 quasar spectra **(12+3)**

11.30-11.35 Julia Piotrowska, K. Chyży, B. Nikiel-Wroczynski, N. Nowak, V. Heesen, V. Vacca, R. Paladino *(Jagiellonian University, Kraków, Poland)* Measurments of galaxy fluxes with CASA from MSSS (LOFAR). **(poster)**

11.35-11.40 Maxim Vasylenko, Yu. N. Kudrya *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Dipole bulk velocity of galaxies from the catalog 2MFGC based on new data sample **(poster)**

11.40-12.10 tea-break

12.10-12.25 Olena Kompaniets, M. Sobolenko, P. Berczik *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Large scale direct galaxy collision simulations of NGC 6240 with central Supermassive Black Hole Binary system **(12+3)**

12.25-12.40 Vadim Voytsekhovskiy, A. V. Tugay *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Simulation of large-scale structure of Universe by random distributions **(12+3)**

12.40-12.55 Fedir Karasenko, O. Sergijenko *(Ivan Franko National University of Lviv, Lviv, Ukraine)* First molecules in the early Universe **(12+3)**

12.55-13.10 Maria Khelashvili, V. I. Zhdanov *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Broadening of spectral lines in a strong gravitational field of compact astrophysical objects **(12+3)**

13.10-13.25 Lyudmyla Berdina, V. S. Tsvetkova *(Institute of Radio Astronomy of the National Academy of Sciences of Ukraine, Kharkiv, Ukraine)* Method for determination the time delays in presence of microlensing **(12+3)**

13.25-13.40 Serhii Dylda, V. I. Zhdanov *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Scalar field models vs hydrodynamics with barotropic equation of state in the homogeneous isotropic cosmology **(12+3)**

13.40-14.20 lunch

Section 'High Energy Astrophysics'

14.20-14.50 Oleksandr Sushchov, P. Homola, P. Poznanski, N. Dhital, K. Almeida-Cheminant *(Institute of Nuclear Physics of the Polish Academy of Sciences, Kraków, Poland)* Cosmic-Ray Extremely Distributed Observatory: a global cosmic ray detection framework **(invited)**

14.50-15.05 Anton Dmytriiev, A. Neronov *(University of Geneva, Geneva, Switzerland)* Time averaged very-high-energy gamma-ray spectra of Mrk 421 and Mrk 501 **(12+3)**

15.05-15.20 Mariana Partii, O. Petruk *(Ivan Franko National University of Lviv, Lviv, Ukraine)* Evolution of electron injection efficiency in SN1987A **(12+3)**

15.20-15.35 Taras Kuzyo, O. Petruk *(Ivan Franko National University of Lviv, Lviv, Ukraine)* Three-Dimensional Simulations of Post-Adiabatic Supernova Remnants in the Interstellar Magnetic Field **(12+3)**

15.35-15.50 Roman Gnatyk *(Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Signatures of the ultra-high energy cosmic ray acceleration by the magnetar SGR 1900+14 in the HAWC gamma-ray observatory data **(12+3)**

15.50-15.55 Pavlo Plotko, B. Hnatyk *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Hydrodynamic modelling of Vela's pulsar and nebula **(poster)**

18.00-22.00 Organ hall / opera hall / etc.

Thursday, April, 27

Section 'Atmospheric studies and space geophysics'

09.00-10.00 morning coffee

10.00-10.15 Andrew Prokhorenkov, L. Kozak, E. Kronberg, B. Petrenko, E. Grigorenko, A. Lui, I. Kundelko *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Analysis of the characteristic frequencies and cascade processes in the Earth magnetosheath **(12+3)**

10.15-10.30 Bohdan Petrenko, L. Kozak, E. Kronberg, E. Grigorenko, A. Prokhorenkov *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* The turbulent and dynamic processes in the Earth's magnetotail **(12+3)**

10.30-10.45 Eugen Tkachenko, Yu. Rapoport, V. Grimalsky *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* The excitation of Large-scale hydromagnetic structures in the ionosphere caused by different types of sources **(12+3)**

10.45-11.00 Dmytro Vlasov, A. S. Parnowski *(Space Research Institute of the National Academy of Sciences of Ukraine; State Space Agency of Ukraine, Kyiv, Ukraine)* Local geomagnetic activity forecasting using the regression method **(12+3)**

11.00-11.15 Yulia Yukhimchuk, G. Milinevsky, V. Bovchaliuk *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Kyiv aerosol pollution during 1-7 and 20-25 September 2015 **(12+3)**

11.15-11.30 Inna Yatsun, G. Milinevsky *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Air pollution by Particulate Matter mass consentration in Kiev **(12+3)**

11.30-12.00 tea-break

12.00-12.15 Denys Hladikov, A. Bovchaliuk *(Taras Shevchenko National University of Kyiv, Ukraine)* Algorithm for generation and processing synthetic data for satellite misson Aerosol-UA **(12+3)**

12.30-12.45 Leonid Olifer, V. Ya. Choliy *(The National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute")* DDscat 7.3.1.C++ new features and possibilities. First experience **(12+3)**

12.15-12.30 Leonid Olifer, V. Ya. Choliy *(The National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute")* On the determination of snowflake properties from simulation of scattered light **(12+3)**

12.45-13.00 Maksym Vasyuta, V. Ya. Choliy *(Taras Shevchenko National University of Kyiv, Ukraine)* On the usage of the Singular Spectrum Analysis for precision estimation and editing of total atmospheric delay time series **(12+3)**

13.00-13.05 Iryna Kundelko, L. Kozak, E. Kronberg, A. Prokhorenkov, B. Petrenko *(Taras Shevchenko National University of Kyiv, Ukraine)* Geomagnetic pulsations as an indicator of substorm **(poster)**

13.05-13.10 Sergii Cheremnykh, I. T. Zhuk *(Space Research Institute of the National Academy of Sciences of Ukraine; State Space Agency of Ukraine, Kyiv, Ukraine)* Discrete ULF modes in the Earth's magnetosphere near the Alfvén frequency minimum **(poster)**

13.30-14.30 lunch

17.45-22.00 Organ hall / opera hall / etc.

Friday, April, 28

Section 'Solar System & Exoplanets'

09.00-10.00 morning coffee

10.00-10.15 Igor Kirilenko, A. A. Golubov *(V. N. Karazin Kharkiv National University, Kharkiv, Ukraine)* Dynamic control of a spacecraft orbit in a noncentral gravity field **(12+3)**

10.15-10.30 Tetiana Hromakina *(V. N. Karazin Kharkiv National University, Kharkiv, Ukraine)* Problems in constraining surface composition of different atmosphereless Solar System bodies using radiative transfer models **(12+3)**

10.30-10.45 Anhelina Voitko, V. V. Troianskiy *(Odessa I. I. Mechnikov National University, Odessa, Ukraine)* Orbital resonances in Saturn system **(12+3)**

10.45-11.00 Alice Horbachova, V. V. Troianskyi, O. A. Bazyey *(Astronomical Observatory of Odessa I. I. Mechnikov National University, Odessa, Ukraine)* Dynamics of multiple system Pluto **(12+3)**

11.00-11.15 Olena Shubina, O. Ivanova, E. Zubko, G. Videen, M. Mommert, J. L. Hora, Z. S. Krišandová, J. Svoreň, A. Novichonok, S. Borysenko *(Main Astronomical Observatory of the National Academy of Sciences, Kyiv, Ukraine)* Colour variations of Comet C/2013 UQ4 (Catalina) **(12+3)**

11.15-11.30 Katerina Bovkun, V. M. Reshetnyk, V. Ya. Choliy *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Gravitational fields model of Solar System small bodies **(12+3)**

11.30-11.45 Olga Mikhalchenko, V. G. Shevchenko*(V. N. Karazin Kharkiv National University, Kharkiv, Ukraine)* Database of asteroids with high-quality occultation diameters **(12+3)**

11.45-12.00 Oleksandr Horbachuk *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* The optical characteristics analysis of a meteor phenomena **(12+3)**

12.00-12.05 Yuliia Kalinina, V. Reshetnyk *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)* Spectral properties of asteroids on the different heliocentric distances **(poster)**

12.05-13.00 Poster section + tea-break

13.00-13.30 Official closure

13.30-14.30 lunch

Saturday, April, 29

09.00-13.00 Museum of Folk Architecture and Life of Ukraine

SOLAR PHYSICS & HELIOSPHERE

Robust method for determination of solar magnetic field strenght

Andrii Prysiazhnyi

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Spatial distribution of the photospheric magnetic fields in the solar faculae region was received using Zeeman splitting of spectral line Fe I 15648Å.

The vertical component of the magnetic field strength vector was calculated by means of the distance $\Delta\lambda_{rb}$ between the Stokes V peaks of this line.

To reduce the influence of noise and for more correct determination of this parameter, the observed profile was approximated by modified basic function of *Wave*-wavelet.

Using multidimensional optimization we determined optimal values of four parameters of approximating function: amplitude, scaling factor, shift parameter and parameter α, responsible for the ratio between the amplitudes of linear and cubic components.

The value of $\Delta\lambda_{rb}$ may be found analytically using known parameters of the approximating function. The offered approach allows to determine the vertical component of the magnetic field for case of low value signal with high level of noise.

This method is stable and provides correct estimations of the magnetic field strength value.

The realization and stability of kink mode $m = 1$ in magnetic tube with discontinuous magnetic field

Anna Tkachenko[1,2], O. Cheremnykh[2], A. Kryshtal[2]

[1] *Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*
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There were studied the conditions of realization and stability of kink modes with azimuthal wave numbers $m = 1$ and $m = -1$ in cylindrical plasma flex with twisted magnetic field and homogeneous current along its axis. There was assumed

permanent vertical magnetic field both inside and outside the flex, surrounded by currentless plasma. Azimuthal magnetic field decreases inversely proportional to the distance from the boundary beyond the flex. The derived dispersion equations for stable and unstable modes in approximation of "thin" plasma flex were analyzed numerically. There was provided an analysis of equations for the case of discontinuous vertical magnetic field on flex's boundary. Conditions of propagation of wave modes have been defined. Results can be applied for the interpretation of solar magnetic tubes behavior, using measurements, provided by spacecrafts.

Properties of wave propagation along the solar atmosphere above the facular region

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This work is based on observations obtained during good seeing at the Vacuum Tower Telescope in He sc i 10825 Åand He i 10830 Åspectral lines in faculae region. From these observations we calculated the intensity and velocity variations in Si i and He i lines following the λ-meter technique. We used ten reference width of the average Si i and He i line profiles. The helium line is formed high in the chromosphere and the silicon line is formed deep in photosphere, where the important role played by convective motions, so waves should be separated from convective motions for Si i line. We obtained the power spectra of velocity variations for both lines. By comparing the spectra we concluded that there is a clear peak at a frequency 3 mHz (5-min), that is stored in the chromosphere. It means, that waves can propagate and reach the chromosphere. We also obtained the intensity-velocity phase shifts $\varphi(I, V)$ and the velocity-velocity phase shift $\varphi(V, V)$ at the different atmospheric heights. The phase shift $\varphi(I, V)$ gives information about the nature of wave propagation (adiabatic or nonadiabatic), and shift phase $\varphi(V, V)$ gives information about the direction of wave propagation (upward or downward) in the solar atmosphere. We concluded, that the waves in the photosphere show upward propagation and the waves in the chromosphere mainly show downward propagation. These waves can transfer significant energy in the solar atmosphere. The amplitude of velocity variations, as expected, increases with height in the atmosphere.

The decameter spikes as a tool for the coronal plasma parameters diagnostic

Mykola Shevchuk[1], V. N. Melnik[1], S. Poedts[2], V. V. Dorovskyy[1], J. Magdalenic[3], A. A. Konovalenko[1], A. I. Brazhenko[4], C. Briand[5], A. V. Frantsuzenko[4], H. O. Rucker[6], P. Zarka[5]

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[3] *Royal Observatory of Belgium, Uccle, Belgium*
[4] *Gravimetrical Observatory, Institute of Geophysics, Poltava, Ukraine*
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The report is devoted to the analysis of the unusual event observed on 14 June 2012 in the frequency range $8 - 42$ MHz. During this event the radiation flux changed stepwise two times. Assuming that these changes of radiation flux could be associated with the changes of the coronal plasma parameters (temperature, magnetic field) and using spikes as a tool for the determination of those parameters we traced how the temperature and magnetic field varied during the time of observations. According to our calculations the magnetic field was about 1.9 G and the temperature varied in the range of $0.1 - 0.6$ MK at the heights $1.6 - 3.3$ solar radii.

STELLAR ASTROPHYSICS & INTERSTELLAR MEDIUM

Analysis of the transient signals in decameter survey of the Northern sky

Ihor Kravtsov[1], V. V. Zakharenko[1], I. Y. Vasylieva[1], S. S. Mykhailova[2], O. M. Ulyanov[1], A. I. Shevtsova[1], A. O. Skoryk[1]

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UTR-2 radio telescope has almost accomplished observations within the confines of the first decameter pulsars and transients survey of the Northern sky. This problem is very important. Due to the widening of radiation cone of neutron stars at low frequency UTR-2 is able to detect radio emission sources which are invisible at higher frequencies. Although now the telescopes operating in the near-UTR 2 frequency range are constructed and try to explore these objects, their effective area is much smaller than the UTR-2 so it is more difficult. With the help of special routines (for RFI mitigation, compensation of dispersion delay and for thorough analysis of each candidate) we chose the set of candidates. The number of candidates is several hundred that allows, on the one hand, to conduct some statistical parameters estimation, and on the other hand - their number is small enough to analyze them all in one place (routine).

We created a database of candidates, each of which has its final record, the original data and its coordinates, coordinates of the central beam, time of detection, dispersion measure (DM), SNR ("signal-to-noise-ratio"), tuned DM and SNR, which are obtained by means of the thorough analysis routine. This allows us to analyze all the signals which are combined by certain common external characteristics. Since we assume that during the low beam position we have to detect the large number of RFI, we need an opportunity to compare the transients parameters distribution at different intervals of declination, time of appearance etc. Also we expect the maximum of galactic latitudes distribution still to be close to the disk component, that's why we analyze common parameters of other candidates which are in the same region of galactic latitudes, such as DM and SNR. We also assume that the candidates number toward the Galaxy Center and Galaxy Anti-center will be greater than number of signals from other directions.

Therefore, all these problems at selected intervals database analysis routine resolves: building of two-dimensional dependencies, distribution histograms of

some parameters, such as right ascensions, declinations, galactic latitudes and longitudes, DMs so on. First results of the analysis are presented.

"Shajn Plane" Input Catalogue

Maksim Gorbunov, N. I. Bondar', V. V. Moskvin, A. N. Rublevskiy, A. A. Shlyapnikov

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We present the Input Catalogue for analysis of results, which were received at realization "Shajn's Plane" on study of the structure of the Galaxy. For creation the our catalogue we used the SIMBAD and VizieR data bases of the CDS, Strasbourg. Input Catalogue contain the information about B, V and R magnitudes and spectral classes about 35000 stars. Preliminary results of comparison the "Shajn's Plane" catalogues and Input Catalogue are present.

Preliminary phase of the polarimetric survey from Mt. Suhora Astronomical Observatory

Agnieszka Gurgul[1], W. Ogłoza[2], G. Stachowski[2], M. Żejmo[3]

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[2] *Mt. Suhora Observatory, Pedagogical University, Kraków, Poland*
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In this presentation observational methods, data and analysis methods, observation plan and possibilities of system development are shown, which are used to detect and examine high-polarised sources. Our aim is to prepare the first polarimetric survey of the Northern hemisphere. This pilot project is conducted using a wide-angle lens equipped with four polarimetric filters and a CCD camera. Calibration and assignation instrumental polarization is a necessary to be able to obtain reliable polarization degree, we get by computing the values of Stokes parameters. Our research may have an influence on the development of future polarimeter which works in the different range of electromagnetic spectrum. Furthermore, we stated that our research results may contribute to the development of polarimetric research, which will become an integral part of more and more popular observational campaigns in the wide range of electromagnetic spectrum.

Optical linear polarization of 74 white dwarfs with the RoboPol polarimeter

Michał Żejmo[1], A. Słowikowska[1] , K. Krzeszowski[1], P. Reig[2,3], D. Blinov[2,3,4]

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We present the first linear polarimetric survey of white dwarfs (WDs). Our sample consists of WDs of DA and DC spectral types in the SDSS r magnitude range from 13 to 17. We performed polarimetric observations using the RoboPol polarimeter attached to the 1.3-m telescope at Skinakas Observatory. We have 74 WDs in our sample, of which almost all are low-polarized WDs with a polarization degree (PD) lower than 1 per cent; only two have a PD higher than 1 per cent. There is evidence that on average isolated DC-type WDs have a higher PD (with a median PD of 0.78 per cent) than isolated DA-type WDs (with a median PD of 0.36 per cent). On the other hand, the median PD of isolated DA-type WDs is almost the same (i. e. 0.36 per cent) as the median PD of DA-type WDs in binary systems with red dwarfs (dM type; i. e. 0.33 per cent). This shows, as expected, that there is no contribution to the PD from the companion if the WD companion is a red dwarf, which is the most common situation for WD binary systems. We do not find differences in the PD between magnetic and non-magnetic WDs. Because 97 per cent of WDs in our sample have a PD lower than 1 per cent, they can be used as faint zero-polarized standard stars in the magnitude range from 13 to 17 of the SDSS r filter.

Flexible Variable Star Extractor — new software for variable star detection using CCD photometry

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A distinct advantage of the CCD photometry is that CCD observations allow us to measure brightness of hundreds stars from the same field of view simultaneously. From our experience, we may say that there is at least one more known

variable star within $10 - 20$ arc minutes from any primary object of investigation and sometimes we may discover an unknown variable star in the same field of view. Over the years different techniques for identifying variable stars were developed. One of the simplest algorithms is based on the dependency of noise level to mean brightness. 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. A variable star should have larger standard error than a constant object of the same mean brightness. Particularly, this algorithm is implemented in the C-Munipack, one of the most popular complete solutions for CCD images reduction. However, this solution does not work well when the data is noisy due to different reasons, so variable stars would appear in a heap of points at the diagram, and many constant stars with lack of data or outlying points will be located above the curve like they are variables. We developed new software for variable stars detection that uses the data sets exported from C-Munipack ("Export varfind data"). The program chooses the comparison stars automatically unless user does not prefer to do it manually. Then it processes all time series using multiple comparison stars method to get final light curves. We implemented few simple filters and criteria that allow reducing the impact of outlying points, imaging artifacts and low quality CCD frames without careful manual time series reduction. At the final step it calculates various variable detection indices including standard deviation, chi-squared, MAD, robust median statistic, normalized excess variance, the von Neumann ratio. It allows plotting a two-channel diagram of selected pair of indices or mean brightness of the star to check any outlying point as variable candidate. One-click light curve and periodogram plot implemented. User can mark star as variable or false alarm to export data of all stars at the final stage. The program is in a beta stage, we are still working on some improvements in scientific and technical parts.

Flare activity of Proxima Cen in the Hα and the resonance Ca II and Na I emission lines

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The results of the Proxima Centauri spectrum analysis are presented and discussed. The Hα (6562.8 Å), Na I (5890.0 and 5895.9) and Ca II (3933.7 and 3968.5) emission lines are studied in order to find a correlation between the temporal intensity changes of these lines. The observations were carried out in 2004-2016 on the HARPS spectrograph of ESO.

Differentially Rotating Strange Quark Stars

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Strange quark stars are considered as a possible alternative to neutron stars as compact objects. A hot compact star (a proto-neutron star or a strange star) born in a supernova explosion or a remnant of neutron stars binary merger are expected to rotate differentially. Rotating compact stars are considered as important sources of gravitational waves for Advanced Virgo/Ligo detectors. We present results of the first relativistic calculations of differentially rotating strange quark stars for broad ranges of degree of differential rotation and maximum densities, including all previously predicted types of solutions, and compare them with results for neutrons stars. Using a highly accurate, relativistic code we show that rotation may cause a significant increase of maximum allowed mass and can temporarily stabilise stars against prompt collapse into a black hole.

Half a century of the observations of the open cluster NGC 188 at telescope MTM-500

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We present a full database of NGC 188 observations obtained at MTM-500 telescope in CrAO. The first image of the old open cluster was acquired with television equipment in 1969. Over 200 nights of television observations of NGC 188 from 1969 to 1997 were included in our database. This cluster was used for the calibration of different objects and field 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. In 2007 this catalogue was compared with other data from VizieR. In 2016 we used NGC 188 observations taken with CCD at MTM-500 and added new data to our database. The database includes three parts: observations (date, time, filters, observers); catalogue of objects (coordinates and magnitudes); images (digitized old photographic observations and new CCD frames).

Photoionization modelling of planetary nebulae with realistic density distribution using detailed method for diffuse radiation calculation

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The approximate methods to calculate the diffuse ionizing radiation (DIR) during the photoionization modelling (PhM) of the nebular environments are frequently used with purpose to increase the calculation speed of modern photoionization codes as well as for simplification of their calculation algorithms.

The most popular is Outward Only method, that in many cases gives the satisfactory precision and speed.

However, in our previous researches it was shown that in some cases of nebulae with constant density the errors, related to usage of approximate method of DIR calculation are significant for spatially extended or optically thin objects. However, constant density is a bit rough assumption. To compare the detailed method of DIR calculation in present work we used more realistic Golovatyy-Malkov density distribution.

Using optimal PhM models for IC 5117 and NGC 7293, obtained by Melekh et al., we recalculated them using detailed method of DIR calculation. Based on these calculations we compared results obtained using aproximate Outward Only and detailed methods of DIR treatment in order to make some recommendations for usage of the last one.

The new ionization correction factors, obtained from results of the multicomponent photoionization modeling of low-metallicity H II regions

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The method for the multicomponent photoionization modeling of the H II region radiation surrounding the starburst knot is presented. The internal structure of the H II region has been determined using the evolutionary model of the superwind bubble from the starburst center. Models of Chevalier and Clegg (1985) and Weaver et al. (1977) have been used to determine the radial distribution of the gas density, the velocity of gas layers, and the temperature in the region of the superwind free expansion and in the cavity, respectively. The chemical abundances of the internal components of the bubble has been set by the results of the modeling of the evolutionary population synthesis. External components of our models describe a high-density, thin layer of gas formed by the shock wave of stellar superwind from the surrounding gas and a typical H II region, respectively. Input model parameters have been taken from the precalculated evolutionary starburst models based on two types of evolutionary tracks. Evolutionary grids of multicomponent low-metallicity models are calculated.

A comparative analysis of the results of their calculation with the observational data has been carried out. The ionic abundances averaged over modeling volume as well as chemical composition assumed in models were used to derive the new expressions for ionization correction factors.

Short time-scale variability in the spectrum of Eta UMa

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We reported the detection of short time-scale variability in the spectrum of hot star η UMa of spectral class B3V. Spectral observations of η UMa were carried out with slitless spectrograph ($R \sim 100$) installed on the 60 cm Carl Zeiss telescope in the Andrushivka Observatory. Spectra were obtained with a time resolution in the sub-second range. It has been found that the η UMa shows rapid variations in the hydrogen lines. The intensity variations in the hydrogen lines varies from 0.2% to 0.5%. Also, we are detected two-peaked line features in the Hydrogen lines.

Regular variability in line profiles in the spectra of stars of early spectral classes are associated with nonradial pulsations and rotation of stars with inhomogeneous large-scale structures in their atmospheres.

Photometric monitoring of CV stars in Lisnyky in 2017

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We report the results of observations of the cataclysmic variable stars in 2017. Cataclysmic variable stars (CV) are stars which irregularly increase in brightness by a large factor, then drop back down to a quiescent state. We searched superhumps in the accretion disks of this stars. Superhump periods in cataclysmic variables are very important, because these periods are close to orbital periods. All the data were obtained on the base of Lisnyky observational station of AO KNU in B, V, R and I bands.

EXTRAGALACTIC ASTROPHYSICS & COSMOLOGY

The kinematic research of Galaxy using data of PMA catalogue

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In this work we present results of kinematic research of Galaxy by means Vector Spherical Harmonics and Ogorodnikov-Milne model using of PMA star proper motions. The PMA catalogue contains more 420 million absolute proper motions of stars in the range between 8 and 21 magnitude, which were obtained with the combination of Gaia DR1 and 2MASS with the mean difference of epochs about 15 years. Most of the systematic errors in the position of 2MASS stars have been eliminated. Using parallaxes of TGAS catalogue in Ogorodnikov-Milne model, the comparison of kinematic parameters of Galaxy from PMA and TGAS data have been produced. The similar results have been obtained using the mathematical model, which is based on the method of decomposition of the stellar vector field velocities on the Vector Spherical Harmonics.

The research of oxygen abundance evolution in massive galaxies

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The oxygen abundances for massive galaxies from Sloan Digital Sky Survey (SDSS DR12) with redshifts less then 0.5 are determined. Values of oxygen abundance are calculated using $N2$, $O3N2$, R and S calibration ratios. We confirmed that for galaxies with stellar masses $\log(M/M_{\odot}) > 10.75$ oxygen abundance is increasing on the time interval from $z = 0.5$ to $z = 0$. Values of growth rate are different depending on calibrations we used to find oxygen abundance and change from 0.08 dex for R-calibration to 0.5 dex for O3N2-calibration in the range of redshift from 0.5 to 0.

Influence of the thin shells with high density on the ionization structure of dwarf galaxies with active star formation

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To check the correct understanding of the physical processes in the dwarf star formation galaxies the modelling methods are usually used. It demands the checking of the correspondence between modelling results and data of the observations. In present work the impact of parameters characterising the thin dense shell (that is necessary to reproduce the diagnostical important relative intensities of the emission lines in the dwarf galaxies spectra) on the resulting spectrum of the nebular environment surrounding the star formation region is investigated. It is shown that even small variations of parameters values of the density peak cause significant differences between resulting spectra. It will allow to determine the parameters of the thin dense shell in real galaxies with enough precision. These parameters will be used to test the codes for chemodynamical simulations of dwarf galaxies evolution.

Two-dimentional correlation function for the distribution of isolated galaxies

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The study of isolated galaxies and comparing their properties with galaxies in groups and filaments can show the influence of galaxy's environment on its properties, such as morphology, nuclear activity in different wavelengths, mass, etc. In the current work our goal was to compare distribution of isolated galaxies selected from 2MIG catalog with a random homogeneous distribution. We found that the correlation function for isolated galaxies and random distribution of galaxies are very similar. This will help us to simulate LSS with our new method of random distributions.

Probing the distant cluster of galaxies JKCS 041 ($z = 1.8$) on the $L - T - M$ scaling relations

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The detailed X-ray analysis of the distant galaxy cluster JKCS 041 using archive data of X-ray *Chandra* Observatory is presented. JKCS 041 is known as one of the most distant galaxy cluster.

We used 3D-models to analyze the radial temperature and surface brightness profiles. The temperature of JKCS 041 within R_{500} is equal 7.4 ± 2.9 keV. The radial temperature profile was used to estimate the total and gas masses within the setting R_{2500}, R_{500} and R_{200}. In addition, we used the temperature and density profiles to derive the entropy profile. We found that total mass of JKCS 041 cluster is equal $M_{2500} = (3.1 \pm 1.8) \times 10^{13} M_{\odot}$, $M_{500} = (2.6 \pm 2.2) \times 10^{14} M_{\odot}$ and $M_{200} = (4.6 \pm 2.9) \times 10^{14} M_{\odot}$. We also estimated the gas mass of JKCS 041 as $M_{g_{2500}} = (8.3 \pm 4.4) \times 10^{12} M_{\odot}$, while at R_{500} is $M_{g_{500}} = (2.4 \pm 1.4) \times 10^{13} M_{\odot}$ and $M_{g_{200}} = (3.1 \pm 1.8) \times 10^{13} M_{\odot}$ at R_{200}. The gas fraction was derived as ~ 10 %, while the dark matter is ~ 90 % within R_{500} and R_{200}. In contrast, at R_{2500} the fraction of gas is about 30%.

We conclude that concentration parameter defined for JKCS 041 are in a good agreement with theoretical expectations. The derived physical properties of hot gas in JKCS 041 were used to create a bigger sample of datapoints on the scaling relations for high-z clusters. The obtained values of temperature, luminosity and total mass were used to probe the evolution of the scaling relations showing consistent with self-similar evolution model.

The mean transmission of the Lyα-forest from the SDSS DR10 quasar spectra

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The intergalactic medium is revealed by the numerous neutral Hydrogen H I absorption lines seen in the spectra of distant quasars, the so-called Lyα-forest, which 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 Lyα opacity of the intergalactic H I to its density and other physical parameters. As a measure of opacity the value F, named the mean 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.

In this work we present a new method of determination of the continuum level which involves using composite spectra of quasars with similar monochromatic luminosity at 1450 Å (l_{1450}) and similar spectral index α_λ within the wavelength range 1215-1450 Å. 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 Lyα-forest.

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Measurements of galaxy fluxes with CASA from MSSS (LOFAR)

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LOFAR (Low Frequency ARray) is an radio interferometric array which carried out Multi frequency Snapshot Sky Survey (MSSS) at 150MHz. As a part of this project I measure fluxes on maps from survey by program Common Astronomy Software Application (CASA). Condition to probe a galaxy was flux at 1.4 GHz higher then 50 mJy. The probe is around 200 for which we are investigating: possibility of flux and inclination dependence, Hubble type and flux realtion, FIR correlation and spectral index. One of the goal is to find if the low frequency spectra steepen and what astrophysical phenomena cause that.

Dipole bulk velocity of galaxies from the catalog 2MFGC based on new data sample

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We used the 2MFGC catalog for investigating of large-scale flows on the basis of the Tully-Fisher relation (TFR). The catalog contains 18020 galaxies selected from the extended sources of the infrared sky survey 2MASS XSC. The majority of galaxies in the catalog are spiral galaxies of late morphological types whose discs are visible almost from the edge. In 2006, a sample of $N = 3074$ 2MFGC galaxies with known galaxy rotation velocities and radial velocities, which are necessary for constructing of the TFR, was created. For 2724 galaxies their individual distances and peculiar velocities based on multiparameter infrared TFR were determined and published. The dipole bulk motion of galaxies of this sample with respect to cosmic microwave radiation is characterized by a velocity of $V = 199 \pm 37$ km/s in the direction $l = 304^\circ \pm 11^\circ$, $b = -8^\circ \pm 8^\circ$ degrees.

Over the recent 10 years the number of 2MFGC galaxies with the necessary data has increased significantly (over 3750 such galaxies in the HyperLEDA database). The aim of this work is to revise early results taking into account new data, and using the main TF data (rotation velocities and radial velocities) only from the HyperLEDA database. The use of this database guarantees an unified approach to mutual recalculation of the widths of the 21-cm radioline and similar in terms of the maximum velocity of rotation.

Another reason to revise earlier results is the appearance of a list of "false" objects among 2MFGC galaxies. The catalog 2MFGC was automatically selected from 1.64 million extended objects of the 2MASS XSC catalog. As it turned out, XSC contained "false" objects, which were moved to the 2MFGC catalog. We excluded "false" objects from consideration.

We confine ourselves comparing only the "old" and "new" parameters of the dipole component of velocity field. We propose to conduct the consideration of higher multipoles on a new sample in another work. New parameters of the dipole bulk motion based on new sample 3173 of 2MFGC galaxies are: bulk velocity $V = 267 \pm 36$ km/s in the direction $l = 308^\circ \pm 8^\circ$, $b = -16^\circ \pm 6^\circ$.

Large scale direct galaxy collision simulations of NGC 6240 with central Supermassive Black Hole Binary system

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We present a set of large scale direct N-body simulations of the galaxy collision with the central Supermassive Black Hole Binary (SMBHB) system. To determine the initial conditions for our set of simulations we use the Chandra X-Ray Observatory archive observation of the first discovered SMBHB in interacting galaxy NGC 6240 situated at $z = 0.0243$. Each galaxy initially was represented as a set of particles (up to N=500k) with Plummer distributions. We investigate the effect of the mass spectrum and particle number of the stellar particles on the hardening rate of the SMBHB. The SMBHBs system is described using the two special high mass particles. Merging time upper limit was obtained for the closely interacting galaxy system NGC 6240.

Simulation of large-scale structure of Universe by random distributions

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Large-scale structure includes galaxy clusters connected by filaments. Voids occupy the rest of cosmic volume. In this work we simulated two-dimensional galaxy distribution using random distributions of clusters and single galaxies. The main assumption was that matter clusterised to initial density fluctuation with uniform distribution. According to Zeldovich theory, low-dimensional anisotropies should increase, that corresponds to appearance of filaments in 2D case.

Thus we generated a net of filaments between clusters with certain length limits. Real galaxy distribution was simulated by changing of random positions of galaxies in filaments and clusters. We generated galaxies in clusters by nonlinear dependencies from surrounding clusters and add uniform distribution of isolated galaxies in voids.

Visual distribution of our model correlate well with the available observations of the Universe at large scales such as Sloan Digital Sky Survey.

First molecules in the early Universe

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We study the formation of first molecules, negative Hydrogen ions and molecular ions in model of the Universe with cosmological constant and cold dark matter. The cosmological recombination is described in the framework of modified model of the effective 3-level atom, while the kinetics of chemical reactions in the framework of the minimal model for Hydrogen, Deuterium and Helium. It is found that the uncertainties of molecular abundances caused by the inaccuracies of computation of cosmological recombination are about 2-3%. The uncertainties of values of cosmological parameters affect the abundances of molecules, negative Hydrogen ions and molecular ions at the level of up to 2%. In the absence of cosmological reionization at redshift $z = 10$ the ratios of abundances to the Hydrogen one are 3.076×10^{-13} for H^-, 2.370×10^{-6} for H_2,1.260×10^{-13} for H_2^+, 1.116×10^{-9} for HD and 8.542×10^{-14} for HeH^+. We investigate also the effect of deviation of the cosmological model from ΛCDM on the evolution of abundances of the first molecules.

Broadening of spectral lines in a strong gravitational field of compact astrophysical objects

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Broad emission lines are commonly observed in the spectrum of compact astrophysical objects. These intrinsically narrow lines, emitted in the inner accretion disk, modify by the interplay of Doopler shifts, relativistic beaming and gravitational light bending during its propagation in strong gravitational field and can potentially be a quite powerful tool to probe the spacetime geometry around these compact objects. In the present work, we study a broad line profile shape caused by the mentioned effects in the case of static spherical symmetric metric. We derive a profile of line produced by special relativistic effects associated with

motion of a radiation source, gravitational redshift and changes of the observed flux caused by null geodesic lines bending in the object gravitational field under assumption of weak gravitational potential.

Method for determination the time delays in presence of microlensing

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The potential astrophysical applications of measuring the differential time delays in gravitationally lensed quasars are widely known. This is, first of all, a possibility to determine the Hubble constant value with no need in the intermediate standard candles. Estimation of the Hubble constant from the time delays requires that they be measured with a rather high accuracy – of the order of 1%. The accuracy of the available measurements is as a rule much lower. One of the most serious complications in time delay determination is due to microlensing events, which distort the intrinsic quasar light curves differently in different quasar images. The choice of a method to eliminate the effect of microlensing in each specific case depends strongly on characteristics of the quasar intrinsic variability and the variability caused by microlensing, in particular, on relationship between the typical amplitudes and time scales of both processes. The differences of our approach from those proposed by other authors earlier do not have a fundamental nature, but provide convenience in calculations. In particular, our approach allows to exclude or add some of the approximating polynomial terms without a necessity to recalculate the coefficients. This provides a simple way to mitigate the effects of microlensing for the case of "slow" microlensing events. The method can be useful for a preliminary express analysis of the data flow expected from the future sky survey programs. The method was tested on the seven-years duration light curves of the gravitationally lensed quasar HE 0435-1223. The corresponding photometry was downloaded from the Strasbourg Astronomical Data Center archive. The analysis of the time delay estimates in the HE 0435-1223 system is presented, as well as a comparison with other published results.

Scalar field models vs hydrodynamics with barotropic equation of state in the homogeneous isotropic cosmology

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We study relations between different approaches to the dynamical dark energy in the homogeneous isotropic Universe, which use hydrodynamical (H) and minimally coupled self-interacting scalar field (SF) models. In general these models are not equivalent. In case of the spatially flat Universe, we found conditions for the SF potential when the energy density of the SF-model satisfies the equations of the H-model. We also found conditions when the H-model solution can be viewed as a limiting solution of the SF-model. The "equivalent" scalar field potentials for some equations of state are found.

HIGH-ENERGY ASTROPHYSICS

Post-Adiabatic supernova remnants in the non-uniform interstellar medium and magnetic field

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Two fundamental problems of the contemporary astrophysics are addressed within CREDO project — the nature of Dark Matter and the existence of ultra-high energy cosmic rays (UHECR). The hypothesis to be tested is that the mentioned mysteries could be explained with just one scenario, known as the Super Heavy Dark Matter (SHDM) decay or annihilation. Its key prediction is that the UHECR flux observed at the Earth should be dominated by photons. On the other hand, the highest energy events observed by the leading collaborations are not considered photon candidates if the present air shower reconstruction procedures are applied. Non-observation of UHECR photons is interpreted as constraints to SHDM scenarios. The key idea of CREDO is to test this assumption experimentally using available infrastructure and analysis methods in a novel way. If cascading of most of the UHE photons before they reach Earth occurs in reality, only results of this process, most likely large electromagnetic cascades, can be observed on Earth. One example of such a process is the preshower effect describing an interaction of an UHE photon and secondary electrons with geomagnetic field. "Superpreshower" (SPS) term was introduced recently to describe a cascade of electromagnetic particles originated outside the Earth atmosphere, no matter the initiating process and distance from the Earth. SPS can be classified with respect to their principal observable properties: distribution in space and time.

The existing experiments are capable to detect SPS with narrow spatial spread, while CREDO idea is to organize infrastructure sensitive to SPS of all classes. If educational cosmic-ray detectors, university particle counters and private electronic devices equipped with photo sensors and appropriate applications could be merged into a worldwide network, it can be used for search for ensembles of cosmic particles arriving at the Earth in extremely extended fronts.

The idea has took the shape of an international collaboration named CREDO. As far as large scale time correlations are the experimental goal, the size of the network and the number of detecting stations has a critical importance. One

of the main ideas to extend CREDO is to involve in the experiment also non-scientists and their pocket devices: smartphones. A worldwide network of cosmic-ray detectors will not only be a unique tool to study fundamental physics, it will also provide a number of other opportunities, including spaceweather or geophysics studies. Among the latter one has to list the potential to predict earthquakes by monitoring the rate of low energy cosmic-ray events.

Status of the project, the ways of its further development as well as extending collaboration with different institutions is to be discussed.

Time averaged very-high-energy gamma-ray spectra of Mrk 421 and Mrk 501

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Blazars are strongly variable sources in the very high-energy (VHE) gamma-ray band (energy range above 100 GeV). Mrk 421 is the closest blazar to the Earth, and also it is the brightest extragalactic gamma-ray source in the VHE gamma-ray sky. Mrk 501 is an another actively studied representative of blazar type of Active Galactic Nuclei, with harder spectrum than Mrk 421. The flux from this type of sources is highly variable, with the flux levels changing by more than order of magnitude during the flaring activity. We present time averaged VHE gamma-ray spectra of Mrk 421 and Mrk 501, which we obtained from analysis of FACT Cherenkov telescope data from 2013 till 2016. We compare our spectrum with earlier observations of the source, performed by HEGRA and VERITAS telescopes. We complement FACT spectral measurements with the lower energy data of Fermi space telescope to obtain the broad-band time-averaged spectra of Mrk 421 and Mrk 501 spanning from 100 MeV to 10 TeV.

We discuss the physical interpretation of the spectra and implications of the precise measurement of the broad-band time averaged gamma-ray spectrum for modelling of the geometrical and physical characteristics of the gamma-ray emitting part of the AGN jet. Also, we use the measurement of the time-averaged properties of Mrk 421 and Mrk 501 in the VHE gamma-ray band to estimate the strength of the secondary gamma-ray emission generated during propagation of the VHE gamma-rays from the source to the Earth.

Evolution of electron injection efficiency in SN1987A

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30 years ago, on February 23, a new supernova has appeared in Large Magellanic Cloud. Since its proximity and well known distance, it is an iconic supernova which allows to study a number of important aspects related to evolution of stars, physics of supernova explosions and cosmic ray acceleration. We present a method to derive the temporal variation of the efficiency of electron injection (i. e. number of particles starting acceleration) from the detailed measurements of the radio spectral index evolution in SN1987A. The method is based on the solution of the time-dependent kinetic equation for diffusive particle acceleration at a strong shock.

Three-Dimensional Simulations of Post-Adiabatic Supernova Remnants in the Interstellar Magnetic Field

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The theoretical model of the supernova remnant (SNR) evolution is typically divided onto tree stages: free expansion, adiabatic and radiative. Yet, one can show that time period between the moment when the adiabatic condition is no longer valid and the moment of thin and cold post-shock shell formation is significant (80% of the adiabatic stage duration) and should not be neglected.

In our previous studies we have considered one-dimensional MHD model of SNR evolution. We have shown that post-shock hydrodynamic parameters undergo substantial changes on the transition to the radiative stage. Yet, the presence of the external magnetic field (namely its tangential component) has a major impact on the transition. The magnetic field pressure compensates the thermal pressure drop due to the radiative losses and also prevents the post-shock gas from collapsing into the very thin and dense shell.

In the current work we have carried out three-dimensional MHD simulations of SNR evolution from adiabatic to radiative stage. This task is computationally expensive and requires a considerable amount of resources. We have traced the flow features on the oblique shocks as well as MHD instabilities development in the post-shock regions.

Signatures of the ultra-high energy cosmic ray acceleration by the magnetar SGR 1900+14 in the HAWC gamma-ray observatory data

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In previous works on searching of potential sources of ultra-high energy cosmic rays (UHECRs) we have distinguished the magnetar SGR 1900+14 as a source of the cosmic rays triplet. Accelerated by explosion on the SGR 1900+14 cosmic rays can "highlight" close molecular cloud (catalog index №53) by the p-p collisions and pion decay in the gamma-ray range. We argue that 2HWC data about unrecognized gamma-ray source 2HWC J1907+084 correspond to the gamma-ray emission from p-p collisions of cosmic rays in the molecular cloud. We calculate the CR luminosity and generation spectrum from possible explosion on the SGR 1900+14 taking into account 2HWC data. We show that the extrapolated up to EeV-ZeV range CR TeV-PeV spectrum can provide the observed $E > 10^{20}$ eV triplet of the UHECRs.

Hydrodynamic modelling of Vela's pulsar and nebula

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We present an analysis of the Vela pulsar and its nebula located in Vela supernova remnant. It was evaluated the concentration of relativistic electrons in the pulsar's nebula using observations of Haslam 408 MHz. For this purpose we calculated the synchrotron radio emission of the Vela's nebula. Vela Supernova remnant radiation was subtracted based on the hydrodynamic method described in I. Sushch (2010).

ATMOSPHERIC STUDIES & SPACE GEOPHYSICS

Analysis of the characteristic frequencies and cascade processes in the Earth magnetosheath

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Interaction of solar wind with the Earth's magnetosphere leads to an exchange of matter and transition of energy and momentum, which affects near-space conditions. This gives rise to a three-dimensional current system and generates large-scale electric fields. Satellite experiments indicate that the boundary magnetospheric regions play a special role in the transformation of the solar wind kinetic energy into charged particle and electromagnetic field energy within the magnetosphere.

Our study devoted to the analysis of the processes in the transition layer of the Earth's magnetosphere from the measurements of the satellite mission Cluster-2.

Within the framework of the research, a spectral and multifractal analysis (analysis of higher order power law of structure function) was conducted.

As a result of wavelet analysis both characteristic frequencies and cascade processes (direct - refer to the transfer of energy from large timescales to the small timescales; and inverse âĂŞ refer to the transfer of energy from small timescales to the large timescales). Herewith, in the transition from solar wind to foreshock region inverse cascade processes occur more often than direct.

Thus, the magnetosphere behaves like a self-organizing system with different characteristic scales. The work is done in the frame of the grant Az. 90 312 from the Volkswagen Foundation ("VW-Stiftung").

The turbulent and dynamic processes in the Earth's magnetotail

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The Earth's magnetosphere is the nonlinear dynamical system, which shows a complex behavior in response to the changes of the solar wind conditions. One of the major displays of the magnetospheric dynamics is a substorm. The magnetospheric substorm onset is, indeed, associated with a change of the tail magnetic configuration from a stressed to a more dipolar shape involving the decrease of the cross-tail current intensity. In more detail, during substorm expansion phase the near-Earth magnetic field configuration has been observed to dipolarize.

In our work we study and compare processes that take place before, during, and after onset of dipolarization. The analysis of magnetic field fluctuations in the tail of the magnetosphere at various spatial and temporal scales for the events of 20/07/2013 and 12/08/2014 observed by the Cluster-2 and THEMIS missions was carried out.

Multifractal analysis (analysis of high-order structure functions), spectral and wavelet analysis was done. Temporal profiles of the time dependence of the fluctuation power for the gyrofrequencies of hydrogen, oxygen, and helium ions are established. Characteristic scales of turbulent processes and intensity changes, as well as the presence of pulsations during dipolarization in the Earth's magnetotail are obtained.

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The excitation of large-scale hydromagnetic structures in the ionosphere caused by different types of sources

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The possibility of ground-based acoustic source influence on the ionosphere with double-frequency transform was investigated. There were performed theoretical computations and experiments and their results were similar. The nonlinear system of hydromagnetic equations physically based on such possibility was solved numerically for different types of initial perturbations: mechanical, magnetic and both of them simultaneously. We have made evaluations of velocity and magnetic fields values and forms. The contribution of the nonlinearity in the forms of the response distributions was obtained. The solutions were found for different latitudes, altitudes and seasons of year, so the seasonal variation of Solar activity was accounted.

Local geomagnetic activity forecasting using the regression method

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The regression modelling approach provides accurate short-term forecasts of local geomagnetic activity. This method is based upon the mathematical statistics and the regression analysis and involved inductive construction of a regression relation between output and input values. The regression modelling method can provide accurate short-term forecast and gives new information about the underlying physics and different local factors affecting the geomagnetic activity. Using this method we developed models of each component of the local magnetic field which allow to forecast them with 3 hours lead time. The software utilizing this method is fast enough to be used in operations.

Kyiv aerosol pollution during 1-7 and 20-25 September 2015

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One of the way of air quality assessment is atmospheric aerosol studying. This issue is becoming increasingly relevant, although it's quite difficult to study. Since the bulk of total aerosol is located in the surface layer of the troposphere (up to 4 km), because of turbulence and various meteorological phenomena influence, it becoming fairly volatile and unstable. During 20-25 September and 1-7, over the Kyiv and outside, it was observed a intense aerosol layer, which was caused

by forest fires and burning peatlands in different parts of Ukraine. To analyze aerosol situation in the atmosphere during September 2015 it was using data from databases: AERONET, Universite Lille, MODIS and CALIPSO/CALIOP. We get data from lidar observations CE370 and networks AERONET and analyzed the basic aerosol parameters from it. Photos obtained by satellite devices allowed to localize the fire places, investigate their impact on the atmosphere, characterize the trajectory of air mass transfer, confirm the fire source of aerosol particles.

CE370 lidar observations showed aerosol distributions with altitude, that gave possibility for studying not only particles concentration, but also mass distribution, particle size, extinction coefficient and Angstrom parameter. During this period, CALIOP recorded high content of aerosol particles with smoke character over Ukraine.

Satellite images showed smoke extent in Kyiv and neighboring regions. With MODIS was prepared fire map for 1-4 and 20-24 September 2015. Air mass trajectories were held through the active fire places. This has contributed aerosol penetration to observations places.

For better understanding the impact of high aerosol concentration on the atmosphere it was estimated radiation forcing with the influence of aerosols and without. We used code GAME (Global Atmospheric ModEL) which allows to calculate change in sunlight flow considering different atmosphere constituents including aerosols.

Air pollution by Particulate Matter mass consentration in Kiev

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Air pollution became an important problem in the world cities. In Ukraine situation is also very severe. In 2012 WHO ranks Ukraine on the first place in the list of death number from air pollution.

We measured Particulate Matter (PM) mass consentration, which shows general pollution of the air. Our results show a pollution picture of Kiev. Unfortunatly PM index often is higher than maximum permissible level.

Algorithm for generation and processing synthetic data for satellite misson Aerosol-UA

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The main task of the Aerosol-UA project is to design, build, and launch into the orbit a multi-functional high-precision polarimeter that will allow make an essential contribution to the study of natural and man-made aerosols and their climatic and ecological effects. The information on cloud conditions and Earth's surface image including determination of the scene, location are need for the correct interpretation of ScanPol data. In the concept of the Aerosol-UA mission the multispectral wide-angle imagerâĂŞpolarimeter (MSIP) was included for that purposes. Spatial and temporal variation of aerosol properties and their impact on the climate are studied by using the ground-based measurements by sun photometers and lidars networks, e. g., AERONET, SKYNET, GLOBE, and satellite observations of optical radiation scattered by the EarthâĂŹs atmosphere and surface.There are several data sets over land and oceans available from various satellite sensors, e. g., MODIS, MERIS, MISR, AVHRR, POLDER, TOMS and OMI. Latest successful satellite experiment for polarimetric aerosol study is POLDER âĂŞ instruments on PARASOL satellite. Aerosol-UA project is based on ideas of NASA Glory mission that failed during launch in 2011. Scanning polarimeter ScanPol of Aerosol-UA mission has been designed as APS/Glory instrument. ScanPol is a Multi-spectal high-precision scanning polarimeter serves for precise orbital measurements of the intensity and polarization of sunlight scattered by the atmosphere and the surface. The main task of this work is to create software for generation and processing synthetic data for ScanPol device and to test it using real data from POLDER/PARASOL mission. The simulated aerosol parameters, obtained from the Aerosol-UA, are in good correspondence to parameters retrieved from POLDER/PARASOL measurements. This preliminary analysis has shown that the number of "independent" measurements is enough for retrieving aerosol characteristics correctly.

DDscat 7.3.1.C++ new features and possibilities. First experience

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Exact analytical solution of scattering and absorption of electromagnetic waves is known only for special geometries of a targets such as spheres, cylinders, cones etc. For more complicated forms the approximate methods are required. One of those methods is the "discrete dipole approximation" (DDA). The exact solution of Maxwell equations is approximated by the set of dipoles, set in the nodes of rectangular net. They build the target on which waves are scattered.

DDScat.C++ is a flexible software for performing the DDA. It is a clone of well-known DDSCAT Fortran-90 code and until version 7.3.0 both packages had the identical functionality. With the new release, DDScat.C++ 7.3.1 has been significantly improved. In particular, changes were made in a "target manager" section of the code, allowing user to create a target with any possible form in just one simple command. Logical operations for targets, loading ones from graphics files (vrml for example) and a large library of primitives were introduced. This work is the first presentation of the new code features to the public.

On the determination of snowflake properties from simulation of scattered light

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Microphysical properties of cirrus clouds may affect climate feedback processes. Those properties are governed by ice crystal shape, size, refractive index, and the mass of ice crystals per unit volume of air. It was suggested, how one can retrieve the properties of ice crystal inside cirrus clouds, but ice crystal forms were mostly left unstudied. Those forms are strictly dependent upon the physical conditions at the place where the crystal is formed. This work is our attempt to fill this gap and introduce the way to determine the ice crystal shape by observing properties of scattered light.

Light scattering on hexagonal-prism-like crystals with and without hexagonal hollows inside was investigated in this study for infra-red and visible electromagnetic waves. It was shown, that for small (compared to the crystal size) hollows the 22° halo keeps the same shape as without hollows. With the increasing of the hollows size – additional halo fluctuations are starting to appear.

On the usage of the Singular Spectrum Analysis for precision estimation and editing of total atmospheric delay time series

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We use Singular Spectrum Analysis (SSA) for precision estimation of time series of total zenith atmospheric delay for a list of European GNSS data stations proceed in Main Astronomical Observatory GNSS processing center. Analysis of the principal components of the series allowed us to clean the series by removing noise out of them. With the capabilities of SSA some gaps in the data were filled out.

Geomagnetic pulsations as an indicator of substorm

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Generation of geomagnetic pulsations is a consequence of the development of magnetospheric and ionospheric plasma instabilities and generation of magnetohydrodynamic (MHD) waves. The connection between magnetosphere and ionosphere associated with the interaction of auroral particles and MHD waves and play important role in the dynamics of the magnetospheric disturbance.

From a magnetospheric physics perspective the substorms is the key problems bounding together many physical processes and phenomena in the magnetosphere and ionosphere.

Geomagnetic pulsations were studied on the basis of measurements the Earth's magnetic field fluctuations from satellites Cluster-2 (C1 and C2) mission for the event August 12, 2014 and measurements from ground-based magnetometers INTERMAGNET system - Amderma (Magnetic longitude 137.78, Magnetic Latitude 65.31), Abisko (101.82, 65.18) and Sodankyla (107.29, 63.81).

There are some pulsations with a period of 4-10 minutes (Pc5) for ground-based measurements and Pi2 for satellites measurements among the obtained results.

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Discrete ULF modes in the Earth's magnetosphere near the Alfvén frequency minimum

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Recently, the one-dimensional inhomogeneous cylindrical model of the magnetosphere is often used for the study of ULF waves with large azimuthal wave numbers. This model significantly simplifies the differential equations of small oscillations for azimuthally small-scale perturbations and permit a fairly complete investigation of their cross-section (towards the magnetic field) structure in the local approximation. However, it remains an open question of the conditions of applicability of the cylindrical model of the magnetosphere. In the present work it is shown that the model of a radially inhomogeneous plasma cylinder adequately describes the ULF perturbations in the Earth's magnetosphere.

Also, an equation of small oscillations of the ULF-mod was obtained. It is shown that this equation takes into account the fast magnetic wave, which is typical for open magnetospheric system. It was found that the appearance of the fast magnetic waves in the magnetospheric plasma leads to the generation of Alfven waves with discrete spectrum. This result confirms that these modes are generated near the peak of the Alfven frequency. In addition, was shown that the discrete Alfven modes are also generated near the minimum of Alfven frequency.

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SOLAR SYSTEM & EXOPLANETS

Dynamic control of a spacecraft orbit in a noncentral gravity field

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The present work is concerned with modeling of systems with a strong dependence on initial conditions (chaotic systems). An example of such a system in the present work is an asymmetric celestial body (for instance, an asteroid), and a spacecraft rotating around it in the noncentral gravity field. A characteristic property is that the distribution of gravitational potential for the system is unknown, which complicates the prediction of its evolution, as well as the satellite control in the orbit of a celestial body. The work includes: (i) creation of an algorithm for calculating the perturbed Keplerian orbit for the satellite around an asymmetric body (asteroid), (ii) Creation of an algorithm aimed to search minimal perturbations for the spacecraft's velocity to maintain satellite in a specified orbit for a definite period of time, (iii) Study of the relationship between the control parameter (e. g. velocity of the satellite) and the functional, characterizing the amount of chaos in the system.

Problems in constraining surface composition of different atmosphereless Solar System bodies using radiative transfer models

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Spectroscopic data in the visible and near-IR wavelength range contain valuable information on surface composition of atmosphereless Solar system bodies, in particular about presence of organic materials, minerals and ices on the surfaces of investigated objects. However, the surface properties are related to the spectral features in a quite complicated non-linear way. Hence, in order to get some constrains on the concentration and physical states of materials that are expected to be present on the targeted surfaces, we need to apply radiative transfer models.

We will discuss problems of modelling for different types of visible and near-infrared spectra, including featureless spectra of Jupiter Trojans and spectra with strong absorption bands of large transneptunian objects. The main source of

uncertainty is the fact that two free parameters of the spectral model, namely the grain size and concentration of the inclusion are mutually interchangeable. As a result, models with different parameters can give similar results. The problems of selecting the most suitable optical constants will be also discussed. Constraints on reliability of information on surface properties from spectral data of the considered Solar system bodies will be given.

Orbital resonances in Saturn system

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In our work, we build a model of motion of Saturn's regular satellites and its rings for study of irregular satellites which are probably captured asteroids. To achieve this goal, we investigated possible orbital resonances between satellites, computed orbital periods of rings and their possible orbital resonances with regular satellites. Also, we computed orbital periods of imaginary material points placed in the middle of rings divisions and their possible resonances with regular satellites.

Authors considers all possible combinations: 252 pairs among regular satellites, 703 pairs among irregular satellites, 1587 pairs among rings and regular satellites and 414 pairs among imaginary satellites placed in the middle of rings divisions and regular satellites. There are no resonances among irregular satellites and the other parts of Saturn system not found. Orbital periods of rings were computed in accordance with Kepler's third law because every element of ring moves like the whole ring.

As the result of calculations, authors found resonances among rings and regular satellites. All regular satellites have resonances among them. Also, we find resonances between imaginary satellites in the middle of rings divisions and regular satellites. Results of this work will be used for our future researches of Saturn's satellites motion.

Dynamics of multiple system Pluto

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In our work we have investigated the dynamics of the Pluto system. We were looking for the moments of the eclipses, resonances between Pluto satellites, secular perturbations in the motion of components. We have also analyzed the dynamics of this system. To search for the moments of the eclipses, we solved five tasks of two bodies, the number of satellites. The next series of eclipses will happen from 2108 to 2112. We have found the angular diameters of all celestial body systems that can participate in the eclipses near the Pluto perihelion and aphelion orbit. Central Solar Eclipse duration: (i) Charon — 1 hour 42 minutes (February 11, 2110), (ii) Nix — 6 minutes (March 10, 2110).

Eclipses with the other satellites will not be observed. We have also considered Pluto eclipse satellites. Pluto has five discovered satellites, some of them move in resonance. Using data of orbital and axial rotation periods of the Pluto system satellites, we conducted a search of possible resonances between all the satellites system. Using the new data, we numerically simulated the evolution of the orbits of Pluto satellites in 800 days, integrating the equations of motion with the Runge-Kutta-8 order method and Gauss-Jackson method. This period of time was extended to 1000 years, we took into account perturbations from Sun and large planets, the equations of motion are integrated using the Everhart 15-order method that allowed us to seek the secular perturbations in the motion of the system components.

Colour variations of Comet C/2013 UQ4 (Catalina)

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We report results of observations of colour in the inner coma of Comet C/2013 UQ4 (Catalina) obtained with the broadband B and R filters. We found significant temporal variations of the colour slope, ranging from -12.67 ± 8.16 % per 0.1 μm

up to 35.09 ± 11.70 % per 0.1 μm. It is significant that the comet changes colour from red to blue over only a period of two days. Such dispersion cannot be characterized with an average colour slope. We also observed Comet C/2013 UQ4 (Catalina) in infrared region using Spitzer telescope and found no significant CO/CO_2 gaseous species in its coma. Therefore, we classified Comet C/2013 UQ4 (Catalina) as a dust-rich comet and attributed the measured colour slope to its dust. We analyzed the colour slope using the model of agglomerated debris particles and concluded that the C/2013 UQ4 coma was chemically heterogeneous, consisting of at least two components. The first component producing the bluest colour is consistent with Mg-rich silicates. There are three different options for the second component producing the reddest colour. This colour is consistent with either Mg-Fe silicates, kerogen type II, or organic matter processed with a low dose of UV-radiation.

Gravitational fields model of Solar System small bodies

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This work is devoted to modeling the distribution of gravitational potential of small bodies. As an example we analyzed here the data for comet 67P/Churyumov-Gerasimenko. The result of our work is the ability to calculate the value of the gravitational potential in any point above the body surface.

Models like ours are often using for testing and accurate calculation of the space missions to Solar system small bodies. Also, we can potentially investigate the complex movements of the close pairs of asteroids. We can also analyze the dynamics of the internal comet coma under the gravitational influence of the comet's core.

There are two approaches to the analysis of the gravitational field of irregular bodies. These are POLYHEDRON and MASCON. In our work we used POLYHEDRON. The MASCON "mass concentration" involves the filling of the body with point masses. In POLYHEDRON method a complex body surface is triangulated with "good" triangles, but internal (the one below the surface) volume is divided into tetrahedrons. This piece of our work was entrusted to a special program (tetrahedralizer) named TetGen.

The second stage of work was performed with a small program written in C++. The program process the data like this: (i) calculates the center of mass for every tetrahedron.

$$x_c = \frac{\sum_{i=1}^{4} x_i}{4}; y_c = \frac{\sum_{i=1}^{4} y_i}{4}; z_c = \frac{\sum_{i=1}^{4} z_i}{4},$$

(ii) calculates the gravitational potential:

$$U = \sum_{i=1}^{N} \frac{\gamma m_i}{r_i},$$

in each point of the mesh (in the preselected plane, whether in the plane XY, or in the XZ, YZ or some else).

As a result we have a text file where one can found the value of step of ours mesh, boundary, where it is built, and the resulting matrix containing the dependence of the type $U(x, y, z)$. Equipotential surfaces might be visualized with the help of IDL software.

Database of asteroids with high-quality occultation diameters

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As is known, the better absolute magnitude of an asteroid and its effective diameter are known at the moment of observation, the more accurately one can determine the value of the asteroid albedo. The most accurate diameters are determined from the results of space missions to asteroids. Unfortunately, there are very few such data today. A high-quality data set of asteroid diameters can be obtained from groundbased observations of stellar occultations by asteroids. On the basis of these data, objects with the quality 3-4 of determining the diameters (the best ones) were selected for their further use in determining the albedo. The resulting database contains about 200 asteroids of different sizes and compositional types in a wide range of semimajor axes (from 1.45 AU to 39.64 AU), eccentricities (from 0.01 to 0.34) and inclinations (from 0.44° to 34.84°). Among the selected asteroids are representatives of the main families and groups, such as Flora, Phocaea, Nysa, Eunomia, Koronis, Eos, Themis, Hilda and Jovian Trojans.

Currently, the database on the diameters of asteroids is supplemented by the values of the absolute magnitude, attributable to the time of determining the size of the asteroid. This database will be used to determine the albedos and create a calibration database for the albedo of asteroids.

We present an analysis of the diameter database, the results of determining the absolute magnitude of selected asteroids, and new estimates of the albedo of individual asteroids. Correlations between the albedo sets obtained from this database and by other methods, mainly from IR-observations, are considered.

The optical characteristics analysis of a meteor phenomena

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Last meteors' observations have shown that the percent of energy that convers from the meteoroid's combustion to a glow depends on its size. In my research, an optical (and also physico-chemical) analysis of the observed meteor phenomena has been carried out, and a theory has been advanced to explain this fact.

Spectral properties of asteroids on the different heliocentric distances

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Small Main-Belt Asteroid Spectroscopic Survey (SMASS) covers 1447 asteroids and it was carried out at a fairly high resolution which allowed to analyze spectra of the surface of asteroids at very narrow wavelength which reveals some new features in the spectra. In this work we have analyzed spectra of asteroids and their spectral features (slope, color indices) for various orbital elements based on the SMASS catalog. We found averaged spectra of asteroids at various heliocentric distances in the main asteroid belt. The dependences of asteroid spectral properties as function of eccentrity and orbit inclination were found too.

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