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

# 22nd Young Scientists' Conference on Astronomy and Space Physics

## Abstracts

Kyiv, 2015

**22nd Young Scientists' Conference on Astronomy and Space Physics**

**April 20 – 25, 2015**
**Kyiv, Ukraine**

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## Preface

This year Young Scientists' Conference on Astronomy and Space Physics is held for the twenty second time. We all have been looking forward to the annual meeting of astronomers at Taras Shevchenko National University of Kyiv. 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 Physics faculty of the Taras Shevchenko National University of Kyiv as a students' conference in 1994. Since 1996 our conference has welcomed young researchers from other universities and scientific institutions. During 1994-2014 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.

On behalf of the organizing committee we would like to express our gratitude to the invited lecturers and participants for contributing lectures and reports. We are especially grateful to Prof. V. M. Ivchenko for the help in conference organization.

*Olena Torbaniuk and*
*Local Organizing Committee*

# PROGRAMME

**Monday, April 20**

**09.00-13.00** - Registration
**13.00-13.30** - Official opening

**Section 'Stellar Astrophysics and Interstellar Medium'**

**13.30-14.15 Viktor Khalack** *(Université de Moncton, Moncton, Canada) Project VeSElkA: Vertical Stratification of Elements Abundance in CP stars* **(invited)**

**14.15-14.30 Jaime Andrés Rosales Guzmán**, R. Mennickent *(University of Concepción, Concepción, Chile) Photometric search for new DPVs using ASAS's Catalogue and Spectroscopic Analysis with CHIRON* **(12+3)**

**14.30-14.45 Paulina Karczmarek** *(Astronomical Observatory, University of Warsaw, Warsaw, Poland) Contamination of RR Lyrae stars from Binary Evolution Pulsators* **(12+3)**

**14.45-15.00 Vitalii Breus**, K. Petrík, S. Zoła, A. Baransky, T. Hegedus *(Odessa National Maritime University, Odessa, Ukraine) On the orbital period of the intermediate polar V2306 Cygni* **(12+3)**

**15.00-15.15 Iryna Kushniruk**, Ya. V. Pavlenko, Z. H. Zhang, M. C. Gálvez-Ortiz *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Spectroscopic investigations of the extreme subdwarf binary system G 224-58 AB* **(12+3)**

**15.15-15.30 Oksana Ivaniha**, O. Pavlenko, N. Pit, K. Antonyuk *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Search of the periodic processes of the SU UMa-type dwarf nova Ursa Majoris in 2013 year* **(12+3)**

**15.30-16.00 tea-break**

**16.00-16.15 Natalia Virnina**, F. Martinelli, M. Mogoryan *(Odessa National Maritime University, Odessa, Ukraine) Modeling of Newly Discovered Pre-Contact Binary Star USNO B1.0 1240-0526950* **(12+3)**

**16.15-16.30 Oleh Buhajenko**, B. Ja. Melekh *(Ivan Franko National University of Lviv, Lviv, Ukraine) Calculation of diffuse ionization radiation by emissivity and opacity maps using DiffRay* **(12+3)**

**16.30-16.35 Marina Galunka**, N. Virnina, T. Krajci *(Odessa Mariinsky High School, Odessa, Ukraine) Study of five newly discovered eclipsing binary stars* **(poster)**

**16.35-16.40 Nadiia Maslova**, N. Virnina, T. Krajci *(Odessa Mariinsky High School, Odessa, Ukraine) Distribution and Kinematics of Cepheids in the Milky Way Galaxy* **(poster)**

**16.40-16.45 Sergii Pokhvala** *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) High-frequency variations in hydrogen spectral lines of the B type star Eta UMa* **(poster)**

**16.45-16.50 Sergii Pokhvala**, B. E. Zhilyaev *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) High-frequency variations of spectral lines in the chromospherically active stars of BY Dra type* **(poster)**

**16.50-16.55 Alisa Shchurova**, E. Pavlenko, V. Malanushenko, O. Antonyuk, A. Sosnovskij, N. Pit *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Light curve of the dwarf nova V503 Cyg: normal outbursts, super-outburst and their features* **(poster)**

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

## Tuesday, April 21

### Section 'Extragalactic Astrophysics'

**09.00-09.30 morning coffee**

**09.30-10.15 Bogdan Wszołek** *(Institute of Physics, Jan Długosz University in Częstochowa, Poland) New live of radiotelescopes from Psary and Komorowo* **(invited)**

**10.15-10.30 Artem Hradyskyi**, O. M. Kopteva *(Oles Honchar Dnipropetrovsk National University, Dnipropetrovsk, Ukraine) Rotational curve of spiral galaxy in Stephanie metric* **(12+3)**

**10.30-10.45 Margaryta Sobolenko**, P. Berczik *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) Black holes merging at the centres of interacting galaxies: coalescence time estimation* **(12+3)**

**10.45-11.00 Inna Yatsun**, Y. I. Izotov *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) The chemical composition of Oxygen and Sulfur in galaxies in the data of the Sloan Digital Sky Survey* **(12+3)**

**11.00-11.15 Alexander Baransky**, V. I. Zhdanov *(Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) The catalog of morphological types of rich PF galaxy clusters* **(12+3)**

**11.15-11.20 Alla Gotsulyak**, S. M. Andrievsky, E. A. Panko *(Odessa I. I. Mechnikov National University, Odessa, Ukraine) The catalog of morphological types of rich PF galaxy clusters* **(poster)**

**11.20-11.50 tea-break**

**Section 'Gravitation & Cosmology'**

**11.50-12.05 Yuriy Taistra**, V. O. Pelykh *(Pidstryhach Institute for Applied Problems of Mechanics and Mathematics of the National Academy of Sciences of Ukraine, Lviv, Ukraine) Null solutions of Maxwell equations in Kerr space-time* **(12+3)**

**12.05-12.20 Maksym Tsizh**, B. Novosyadlyj *(Astronomical Observatory of Ivan Franko National University of Lviv, Lviv, Ukraine) Dynamics of dark energy in collapsing halo of dark matter* **(12+3)**

**12.20-12.35 Iryna Ivanchenko**, V. M. Gorkavenko *(Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) Vacuum effects in the presence of a finite thickness magnetic tube* **(12+3)**

**12.35-12.50 Olena Torbaniuk**, G. Ivashchenko *(Taras Shevchenko National University of Kyiv, Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) Measurement of the Ly$\alpha$-forest transmission from the SDSS DR10 quasar spectra* **(12+3)**

**12.50-13.05 Anton Rudakovskyi**, D. Iakubovskyi *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Reionization in cold, warm, cold+warm dark matter model* **(12+3)**

**13.05-13.10 Valentyna Sadova**, D. Iakubovskyi *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Identification of the optimal object observations to confirm the nature of the line at 3.5 keV* **(poster)**

**15.00-19.00** City tour (walking tour)

## Wednesday, April 22

### Section 'Solar Physics and Heliosphere'

**09.00-09.30 morning coffee**

**09.30-09.45 Ann Tkachenko**, N. I. Lozitska *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Flare and sunspots statistics comparison: investigating flare prediction possibilities* **(12+3)**

**09.45-10.00 Abid Ali Abid**, S. Ali, R. Muhammad *(Federal Urdu University of Arts, Science and Technology, National Center for Physics, Islamabad, Pakistan) Dust grain surface potential in a non-Maxwellian dusty plasma with negative ions* **(12+3)**

**10.00-10.15 Igor Gala**, L. V. Kozak, A. Prokhorenkov, A. T. Y. Lui *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Transfer processes in the transition layer of solar wind and the Earth's magnetosphere* **(12+3)**

**10.15-10.20 Antonina Klyuyeva**, B. A. Shakhov, Yu. L. Kolesnyk, Yu. I. Fedorov *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) The model of galactic cosmic rays distribution near the Earth's orbit under the interaction with quasi-stationary stream of fast solar wind* **(poster)**

**10.20-10.25 Antonina Klyuyeva** *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) Main features of Forbush effects caused by various sources of solar wind disturbances* **(poster)**

**10.25-10.30 Valeria Lyakh**, V. G. Lozitsky *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Magnetic field diagnostics in solar faculae using BSF method* **(poster)**

### Section 'Atmospheric studies and space geophysics'

**10.30-11.15 Gennadi Milinevsky** *(Taras Shevchenko National University of Kyiv, Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) Remote sensing of aerosol in the terrestrial atmosphere* **(invited)**

**11.15-11.45 tea-break**

**11.45-12.00 Eugen Tkachenko**, Yu. Rapoport, Yu. Selivanov, V. Ivchenko *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Propagation of planetary electromagnetic waves and atmospheric-gravitational waves in the Earth's ionosphere, theory and modeling* **(12+3)**

**12.00-12.15 Evgeny Udodov**, A. Shavrina, G. Milinevsky, E. Venger, Ya. Romanyuk, I. Syniavsky, V. Kyslyi, A. Liptuga *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Improving troposphere ozone height profiles by combined FTIR and Umkehr methods* **(12+3)**

**12.15-12.30 Vladislav Mogylchak**, G. Milinevsky *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Spatio-temporal features of stratosphere ozone distribution over Ukraine by 1979-2014 satellite data* **(12+3)**

**12.30-12.45 Andrew Prokhorenkov**, L. V. Kozak, A. T. Y. Lui *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Statistical analysis of the transition processes in the Earth's magnetosheath* **(12+3)**

**12.45-12.50 Yulia Yukhimchuk** *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) The ozone mini-holes and antymini-holes in stratosphere over Kyiv during 2010–2015* **(poster)**

**17.45-22.00** Organ hall / opera hall / etc.

## Thursday, April 23

### Section 'High Energy Astrophysics'

**09.00-09.30 morning coffee**

**09.30-10.15 Ievgen Vovk** *(Werner-Heisenberg-Institut, Max-Planck-Institut für Physik, Munich, Germany) On the nature of the gamma-ray emission of Active Galactic Nuclei* **(invited)**

**10.15-10.30 El Miloudi El Moussafir** *(Université Hassan II Mohammedia, Casablanca, Morocco) Characterization of lead titanate thin films prepared by sol gel process* **(12+3)**

**10.30-10.45 Iurii Babyk**, M. Chernyakova *(Dublin City University, Dublin Institute for Advanced Studies, Dublin, Ireland) Multiwavelength observations of the binary system PSR B1259-63/LS 2883 around the 2014 periastron passage* **(12+3)**

**10.45-11.00 Taras Kuzyo**, O. Petruk, V. Beshley *(Ivan Franko National University of Lviv, Lviv, Ukraine) The MF strength estimation from the non-thermal X-ray radial profiles of Tycho SNR* **(12+3)**

**11.00-11.15 Anton Dmytriiev**, A. Neronov, S. Toscano *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Study of TeV blazar Mrk 421 with the Cherenkov telescope FACT* **(12+3)**

**11.15-11.45 tea-break**

**11.45-12.00 Roman Gnatyk** *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Search for the sources of the ultra high energy cosmic rays with energies above $10^{20}eV$* **(12+3)**

**12.00-12.15 Iryna Boiarska**, D. Iakubovskyi *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Determination of Astro-H sensitivity with respect to the unidentified line at 3.5 keV* **(12+3)**

**12.15-12.30 Maria Khelashvili**, B. Hnatyk, L. Zadorozhna *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Synchrotron radiation from the bow shock around the magnetosphere of superconducting cosmic string* **(12+3)**

**12.30-12.45 Anatoliy Tugay**, V. Sadova *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) A model of X-ray emission of Seyfert 1 galaxies* **(12+3)**

**12.45-12.50 Ganna Donskykh**, M. I. Ryabov, A. L. Sukharev, M. F. Aller *(Odessa I.I.Mechnikov National University, Odessa, Ukraine) Using the methods of wavelet analysis and singular spectrum analysis in the study of radio sources 3C345, OJ 287, CTA102 and 3C446* **(poster)**

**12.50-12.55 Pavlo Plotko**, I. G. Slyusarev, V. G. Shevchenko, Y. N. Krugly, V. G. Chiorny *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) The optical afterglow of gamma-ray burst GRB130427A* **(poster)**

**12.55-13.00 Kateryna Sukach**, A. Bohdan, V. Marchenko *(Taras Shevchenko Chernihiv National Pedagogical University, Chernihiv, Ukraine) Analysis of spatial and temporal and spatial properties of object near Centaurus A* **(poster)**

**13.00-13.05 Lidiia Zadorozhna**, B. Hnatyk, M. Khelashvili *(Taras Shevchenko Chernihiv National Pedagogical University, Chernihiv, Ukraine) Fast radio bursts as electromagnetic radiation from cusps on superconducting cosmic strings* **(poster)**

## Friday, April 24

### Section 'Solar System & Exoplanets'

**09.00-09.30 morning coffee**

**09.30-10.15 Oleksiy Golubov** *(V. N. Karazin Kharkiv National University, Kharkiv, Ukraine) Yarkovsky and YORP effects: importance of non-gravitational forces for asteroid's evolution* **(invited)**

**10.15-10.30 Mahesh Herath**, T. Van Hoolst *(Katholieke Universiteit Leuven, Leuven, Belgium) An approximate measurement of the love numbers and tidal effects of Neptune on Triton* **(12+3)**

**10.30-10.45 Ulyana Pyrohova**, O. Golubov *(V. N. Karazin Kharkiv National University, Kharkiv, Ukraine) Dependence of the YORP effect on the asteroid shape* **(12+3)**

**10.45-11.00 Olena Shubina**, O. Ivanova, N. N. Kiselev, V. L. Afanasiev *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Photometric and spectral investigation of the comet 103P/Hartley-2* **(12+3)**

**11.00-11.15 Fateryna Frantseva**, *(SRON Netherlands Institute for Space Research, Kapteyn Astronomical Institute, RUG, Groningen, Netherlands,) Delivery of organic material and water to planets through asteroid impacts* **(12+3)**

**11.15-11.30 Serhii Yasenev** *(National Aviation University, Kyiv, Ukraine) Analysis of self-gravitating satellites of the planets in the Solar System* **(12+3)**

**11.30-11.45 Anton Kostetskiy** *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Research activities centaur Echeclus 174P using the methods of photometry* **(12+3)**

**11.45-12.00 Alexander Baransky**, A. Simon, D. I. Vidish, A. I. Vorontseva *(Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) 14P/Wolf, 15P/Finlay, 16P/Brooks 2 and 21P/Giacobini-Zinner comets' disintegration study* **(12+3)**

**12.00-12.15 Larysa Rohachova**, Y. G. Shkuratov, V. V. Korokhin, V. G. Kaydash, Y. I. Velikodsky, D. G. Stankevich, G. Videen *(V.N. Karazin Kharkiv National University, Kharkiv , Ukraine) Ejecta deposits of Copernicus crater* **(poster)**

**12.15-12.20 Sergii Zaitsev**, N. Kiselev, V. Rosenbush, S. Kolesnikov *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) Polarimetry of saturnian satellite Rhea* **(poster)**

**12.20-12.25 Alona Mozgova** *(Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) A possible physical mechanism of meteor flares* **(poster)**

**12.25-12.30 Volodymyr Troianskyi**, O. A. Bazyey *(Astronomical Observatory of Odessa I.I. Mechnikov National University, Odessa, Ukraine) Effect of nonsphericity of gravitational field of the asteroid on the its satellites orbits evolution* **(poster)**

**12.30-12.35 Andrew Simon**, V. Vasylenko, M. Andreev, V. Godunova, V. Reshetnyk, O. Sergeev, W. Thuillot *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Observations of near-Earth asteroids at Lisnyky and Terskol from 2013 to 2015* **(poster)**

**12.35-12.40 Andrew Simon**, V. Ponomarenko, K. I. Churyumov *(Taras Shevchenko National University of Kyiv, Kyiv, Ukraine) Spectral investigation of long-periodic comet C/2014 Q2 (Lovejoy)* **(poster)**

**12.40-12.45 Yana Shliakhetska**, Y. Kuznyetsova, V. Krushevska, A. Vidmachenko *(Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine) Chromospheric activity of stars in systems with exoplanets based on photometric observational data* **(poster)**

**12.45-13.45 Poster section + tea-break**

**13.45-14.15 Official closure**

**Saturday, April 25**

**08.30-12.00** Excursions to Kyiv-Pechersk Lavra

**13.00-15.00** Museum of Folk Architecture and Life of Ukraine

# INVITED LECTURES

### Project VeSElkA: Vertical Stratification of Elements Abundance in CP stars

Viktor Khalack

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The phenomenon of chemically peculiar stars is considered through a prism of different approaches for the spectral abundance analysis and their know results.

The first results on detection of vertical abundance stratification of chemical species in stellar atmospheres of several slowly rotating chemically peculiar CP stars are presented and considered as an indicator of the effectiveness of the atomic diffusion mechanism responsible for the observed peculiarities of chemical abundances. This study is carried out in the frame of the VeSElkA (Vertical Stratification of Elements Abundance) project for which 35 chemically peculiar stars have been observed with the spectropolarimeter ESPaDOnS at CFHT.

### New live of radiotelescopes from Psary and Komorowo

Bogdan Wszołek

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In 2010 four radiotelescopes were dismounted in Psary (Poland) with hope that they will be again fully valuable instruments for radioastronomy and/or for communication with space devices. Dishes of parabolic antennas have diameters 9, 13, 13, and 16 meters. Three of four antennas are already built in Rzepiennik Biskupi (RT-9), Częstochowa (RT-13) and Cieszęcin (RT-13). Furthermore, in 2014 5.4 meter radio frequency terminal was dismounted in Komorowo and installed in Rzepiennik Biskupi. We are searching for specialists to cooperate with us to make use of these instruments as soon as possible.

## Remote sensing of aerosol in the terrestrial atmosphere

Gennadi Milinevsky[1,2]

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The distribution and properties of atmospheric aerosols are still poorly known to be used in comprehensive climate modeling. Aerosol climate impacts are comparable to those of the greenhouse gases. However, this influence is more difficult to measure, especially with respect to aerosol micro-physical properties and estimates of anthropogenic component effect. Currently, there are many satellite missions studying aerosol distribution in the terrestrial atmosphere, such as MISR/Terra, OMI/Aura, AVHHR, MODIS/Terra/Aqua, CALIOP/CALIPSO. To improve the quality of data and climate models as well as to reduce aerosol climate forcing uncertainties, several new missions are planned. The NASA's Aerosol Cloud Ecosystems (ACE) mission is expected to be launched in 2024, preceded by the Pre-ACE mission in 2019 or later. After successful nine years of operation of the POLDER/PARASOL aerosol space mission of the CNES, an advanced aerosol polarimeter in the framework of the project 3MI/EPS-SG is planned for launch in 2010 or later. After the failed launch of the Glory mission in 2011, the gap in aerosol orbital instrument has appeared because the scheduled launches of similar types of instrument are planned for 2019 or later. This is one of the reasons that we proposed a scientific space project with an aerosol photometer-polarimeter accompanied by a wide-angle panoramic multi-spectral camera on-board to study detailed physical parameters of natural and anthropogenic aerosols and estimate their chemical composition (refractive index). A detailed analysis of an aerosol remote sensing concept based on precise orbital measurements of the intensity and polarization of sunlight scattered by the atmosphere and the surface shows that an orbital multi-functional high-precision polarimeter can provide an essential contribution to the study of natural and man-made aerosols and their climatic and ecological effects. We describe the development of the Ukrainian space project Aerosol-UA, in particular, the multi-channel scanning polarimeter (ScanPol) designed for remote sensing studies of the global distribution of aerosol and cloud properties (such as size, morphology, and composition) in the terrestrial atmosphere by polarimetric and spectral photometric measurements of the scattered sunlight.

Acknowledgements. The work was supported by the Special Complex Program for Space Research 2012-2016 of the National Academy of Sciences of Ukraine (NASU), project PICS 2013-2015 of CNRS and NASU, and project 11BF051-01-12 of the Taras Shevchenko National University of Kyiv.

## On the nature of the gamma-ray emission of Active Galactic Nuclei

Ievgen Vovk

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Active Galactic Nuclei constitute a half of the known sources of the high-energy gamma-ray emission, but still the exact location and properties of their emission regions are uncertain. Here I will present the recent findings from the high-energy observations of the Active Galactic Nuclei with both space-born and ground-based instruments, shedding a light to these questions. The detection of the fast variability in several of these sources already suggests that the gamma-ray emission region is comparable or even smaller than the central black hole size, indicating its tight connection with the latter. I will also report on the surprising observation of a gamma-ray loud AGN, where the specific viewing conditions allowed for the first time to clearly resolve the size of the gamma-ray emission region, thus suggesting a resolution to the long-standing puzzle of the origin of the gamma-ray emission of these objects.

## Yarkovsky and YORP effects: importance of non-gravitational forces for asteroid's evolution

Oleksiy Golubov

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Both the Yarkovsky and the YORP effects appear due to recoil forces created on the surface of an asteroid by reemitted solar radiation. The Yarkovsky effect causes the asteroid to change its orbit, while the YORP effect alters the asteroid's rotation. In the last 15 years we witnessed a drastic increase in our theoretical understanding and observational confirmation of the two effects, so that now they firmly established themselves as major building blocks of the general theory of asteroid evolution (yet under construction).

The Yarkovsky effect was first proposed in 1900, but its first observational confirmation waited until 2003. It appears when an asteroid's surface has a finite thermal inertia, so that the maximal temperature at each point of the surface is reached not at noon but in the afternoon. Then the evening side of the asteroid is warmer than the morning side, it emits more thermal radiation, and experiences a bigger recoil pressure. The resulting pressure force changes the asteroid's orbit. If

after this alteration of the orbit's semimajor axis the asteroid appears in resonance with Jupiter, its orbit is strongly perturbed, and the asteroid may be lead to the inner Solar system. This process turns to be the major supplier of near-Earth asteroids, and thus the cause of asteroid hazard.

The Yarkovsky–O'Keefe–Radzievskii–Paddack (or YORP) effect was first proposed in 2000 as a torque created by recoil pressures on an asymmetric asteroid. It was observationally detected in 2007 when phase shift in observed rotation of asteroids inexplicable by other mechanisms was proved to be in a good agreement with YORP predictions. For kilometre-sized asteroids typical timescales at which YORP drastically changes rotation of an asteroid are of the order of 10 Myr, and scale with the size of the asteroid to the power of minus 2. It implies that distribution of asteroids smaller than 10 kilometres over their rotation periods and orientations of rotation axes is shaped by the YORP effect.

In the talk I will review the history of the Yarkovsky and YORP effects, describe their physical mechanism and the mathematical formalism used for their modelling, with the special focus on the limitations of the standard theory and its possible genaralizations. I will discuss the novel concept of the tangential YORP, a torque that alters even the rotation of symmetric asteroids due to uneven heat conductivity in small stones composing the surface. Finally, I will consider the overall evolution of an asteroid experiencing the YORP effect, its stable and unstable rotation equillibria, tumbling, rotation fission, and distribution function over rotation rates.

# STELLAR ASTROPHYSICS & INTERSTELLAR MEDIUM

## Photometric search for new DPVs using ASAS's Catalogue and Spectroscopic Analysis with CHIRON

Jaime Andrés Rosales Guzmán, R. Mennickent

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We have searched the ASAS1 catalogue of semi-detached eclipsing binaries (Pojmnski 1997) for interacting binaries of the type Double Periodic Variable (DPV). These are intermediate-mass binaries characterized by a long photometric period lasting about 33 times the orbital period (Mennickent et al. 2003, 2012a, 2013, Poleski et al. 2010). This long periodicity has been interpreted as evidence of mass loss cycles (Mennickent et al. 2008, 2012b). We performed a visual inspection of the light curves provided by ASAS, and selected DPV candidates characterized by long-term tendencies in the upper and lower boundaries of the forest of data points. We have two confirmed new DPVs: V495 Cen and V4142 Sgr. They show a total primary eclipse and have relatively long orbital periods. They are ideal targets for follow-up spectroscopic studies and light curve modeling. We checked the WISE image survey (Wright et al. 2010), especially in the band W4, and find that none of these targets show evidence of close nebulosity, which could be relevant when discussing systemic mass loss and evolutionary stage. We determined the orbital and long periods by using the PDM IRAF program (Stellingwerf 1978) and we disentangled the two main photometric frequencies by using a code specially designed for this purpose by Zbigniew Kolaczkowski. The code adjusts the orbital signal with a Fourier series consisting of the fundamental frequency plus their harmonics. The orbital period of V495 Cen is $33.490 \pm 0.018$ days and the long cycle is 1283 days, whereas V4142 Sgr shows an orbital period of $30.633 \pm 0.027$ days and a long cycle of 1206 days.They are the DPVs with the longest periods found until now and we do not rule out to find new DPVs in the new ASAS4's Catalogue in the next future.

Parameters of binary systems like DPVs are extremely complicated generally this systems may be recognisable as spectroscopic binaries (SBs) either because the spectrum is composite or because it shows radial velocity variations or both but not all binary systems are DPVs. For this we will identify lines of the hot and cold stellar components and determine their spectral types, disentangle spectral features of the system component determining a dynamical solution for the stellar

masses, solve the inverse problem of the light curve for a binary system with accretion disc, using a code described by Mennickent & Djurasevic 2013, providing stellar and disc parameters for the system, we will find the best synthetic model by multi-parametric minimization as too the determining the binary star age, mass transfer rate and fraction of mass lost. This process will allow us to reconstruc the past history of this binary star and understand its present evolutionary stage and reveal sites of larger emissivity in the system, eventually gas streams and co-rotating magnetic structures.

### Contamination of RR Lyrae stars from Binary Evolution Pulsators

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Binary Evolution Pulsator (BEP) is a low-mass (about 0.25 $M_{\odot}$) member of a binary system, which pulsates as a result of a former mass transfer to its companion. BEPs mimic RR Lyrae stars, but have completely different internal structure and evolution history. Although there is only one known BEP (OGLE-BLG-RRLYR-02792), it has been estimated that about 0.2% of objects classified as RR Lyrae stars can actually be Binary Evolution Pulsators. In this work, the contamination value of 0.2% is re-computed using population synthesis method. BEP's characteristics are presented, and on this basis, a number of methods is suggested to distinguish BEPs from RR Lyrae stars.

### On the orbital period of the intermediate polar V2306 Cygni

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The pulsating X-ray source 1WGAJ1958.2+3232 was discovered by Israel et al. (1998). Negueruela et al. (2000) announced the system as the intermediate polar. Zharikov et al. (2001) obtained time resolved spectroscopy and R-band photometry from which they determined an orbital period of 4 hours 36 minutes and confirmed the pulsation period of 733 seconds. Later on, Norton et al. (2002) obtained UBVRI photometry and reported that the orbital period was 5.387 hours, corresponding to the $-1$ day alias of the period found by Zharikov et al. (2001). Just after it, Zharikov et al. (2002) re-analyzed this system using own photometric and spectroscopic data along with the data by A. Norton and confirmed their previously found orbital period of 4 hours 35 minutes. The star was named as V2306 Cyg in 2003.

The CCD photometric observations of the V2306 Cyg were obtained using 60-cm Zeiss-Cassegrain telescope at the Observatory and Planetarium in Hlohovec, Slovakia, 50-cm Zeiss reflector at the Fort Skala observatory in Krakow, Poland, 70-cm AZT-8 telescope at the Astronomical Observatory of Taras Shevchenko National University in Kyiv, Ukraine and 50-cm reflector of Baja astronomical observatory, Hungary. Along with our time series we analyzed all long CCD time series published in the AAVSO database (14 runs).

To determine spin maxima and orbital minima timings we used trigonometric polynomial approximation. We choose 2-periodic variability model for smoothing, where the periods vere published orbital and spin period values. We calculated only one moment per set of observations (i.e. per night) due to better accuracy.

To study period variations we used (O-C) analysis. Two O-C diagrams were built: for spin maxima and for orbital minima timings. We tried to study variations of the spin period of V2306 Cygni. Unfortunately, relatively short timescale and large scatter at the (O-C) makes all attempts to correct cycle miscount ambiguous. Longer time base is needed.

We used the preliminary value of the orbital period of $0^d.22446$ (Norton et al, 2002) among two published aliases of each other for (O-C) analysis due to larger amplitude of variations at the phase curves for some selected nights of observations. We found regular cycle miscount, and minima timings obtained during different years looked like separate trends not connected to each other. We restored correct cycle numbers and smoothed the (O-C) diagram with the linear fit. Using coefficients of the polynomial, we determined better value of the orbital period of V2306 Cyg of 0.2232685(24) days. Similarly, we checked (O-C) diagram for the period of $0^d.1825179$ which is a daily alias of our "corrected" value and close to published by Zharikov et al. (2001). There were also linear trends from year to year. Using analogous calculations we determined the new value of the orbital period of $0^d.181545 \pm 0^d.000003$ which is slightly different from the value of $0^d.181195 \pm 0^d.000339$ determined from radial velocities by Zharikov et al. (2002). Orbital phase curves of V2306 Cyg calculated with this period show larger amplitudes, then all previously published or obtained by us ones for most seasons. Formally the accuracy estimate of our result is 113 times better.

### Spectroscopic investigations of the extreme subdwarf binary system G 224-58 AB

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We present results of the high resolution spectral analysis of the metal-poor binary G 224-58 AB.

We provided detailed analysis of spectra of both components to probe M subdwarf metallicity with an esdK5+esdM5 binary. Using the procedure developed by Pavlenko et al. (2013) we determined main characteristics of G 224-58 A atmosphere such as effective temperature $T_{eff} = 4625 \pm 100$ K, surface gravity $\log g = 4.5 \pm 0.5$, microturbulent velocity $v_t = 0.5 \pm 0.1$ km/s and abundances of Ca, Cr, Fe, Mg, Mn, Na, Ni and Ti. The rotational velocity $v \sin i = 2.0 \pm 0.8$ km/s is on the accuracy limit. For the secondary component we obtained $T_{eff} = 3200 \pm 100$ K, surface gravity $\log g = 5.0 \pm 0.5$ using abundances of the primary component to compute the grid of model atmospheres.

### Search of the periodic processes of the SU UMa-type dwarf nova Ursa Major in 2013 year

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We present a result of the SU UMa-type dwarf nova CI UMa, observations have been carried out during the 2013 March – June and October with 1.25-m telescope of the Crimean Astrophysical Observatory. Our observations covered two

outbursts and quiescent state over 24 nights. We found so-called "superhumps" during the first superhump and defined it as a "superoutburst". The superhump period was $0^d.0623(2)$. In quiescent state CI UMa displayed the brightness variations with period of $0^d.0608(2)$, which were identified as orbital period. Using the values of the superhump and orbital periods, we estimated the mass ratio of the secondary component to the primary one, $q = 0.11(2)$.

## Modeling of Newly Discovered Pre-Contact Binary Star USNO B1.0 1240-0526950

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We discovered USNO B1.0 1240-0526950 to be a close eclipsing binary star of EB-type in 2013, while observing its vicinity in *R*-band. We've noticed then, that apart from rather short period of 0.48 days, characteristic for systems which are in contact or close to it, the phase curve demonstrates a significant difference in minima depths $m_I - m_{II} = 0.255^m$, which indicates a large difference in components' temperatures. Thus we preliminary concluded that this system might belong to an important narrow poorly-understood class of binaries, which are in physical contact, but not in thermal one. Another feature of this binary, observed in 2013, is uneven maxima, which is called O'Connell effect, supposed to be caused by cool spots on one or both components of the system. However, in 2014 this effect disappeared, leaving nearly perfectly symmetric phase curve in both, R- and V-bands.

The goal of the present work was to determine the most probable parameters of this binary and to find a combined solution for both observational sets, which will differ only by parameters of the spot.

As USNO B1.0 1240-0526950 is a rather faint star with mean magnitude in of $R_{mean} = 14.086^m$, we have no possibility to collect spectral observations and thus to determine spectral mass ratio. However, using VR observations, we determined the temperature of hotter component $T_1 = 7290$ R. Assuming the secondary component to be a convective star, we suggested that the cool spot is more likely to be present on it, and be caused by magnetic activity. For modeling procedure we used Wilson-Devinney code supplied with Monte-Carlo searching algorithm (by S. Zola). We computed two sets of models, one of them contains a cool spot in both years, another one suggested the presence of a spot only in 2013. In both

cases we obtained close detached system, which might be in a pre-contact stage, and thus did not achieved a contact configuration and thermal contact stage.

### Calculation of diffuse ionization radiation by emissivity and opacity maps using DiffRay

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For detailed diffuse ionization radiation (DIR) treatment code DiffRay was developed. This program uses emissivity and opacity maps, calculated by photoionization code, and than integratesDIR over 3D volume in any point incide or outside the nebula. To test DiffRay, we run it in Outward Only mode to compare results with those, obtained from Cloudy.

Using DiffRay the synthetyc spectra for different aperture positions for galaxy NGC 1569 was obtained. Calculated intensities OII lines were lower then observed. It is shown that low ionization zone can be produced by clumps. We calculated spectra for different clumps locations and densities, and concluded that clumps must be placed in the wall.

### Study of five newly discovered eclipsing binary stars

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We present the results of photometric study of five close eclipsing binary systems, which we discovered in 2012. The observations were collected using K28 (D=280 cm) telescope of Astrokolkhoz Observatory (AAVSO), equipped with SBIG ST-8 monochrome CCD camera and two Sloan filters: i and r.

The periods were calculated using classical Lafler-Kinman method, magnitudes in maxima and minima were determined using polynomial approximation method. Four of these stars were identified as EW-type contact variables with period range from $0.27^d$ to $0.61^d$, and one of them was classified as EA-type variable

with period of $1.21^d$. Two of studied EW-type binaries are particularly interesting due to asymmetry in maxima, which is called O'Connell effect and is usually associated with the presence of "cold" or "hot" spots in the chromosphere of one of the components. The EA-type star apparently represents an example of in-between stage, as its curve has features characteristic to EB-type binaries as well as to EA-type stars, and may be either a semi-detached or a detached system.

All studied variables are approved in The International Variable Star Index (VSX) catalogue operated by AAVSO.

## Distribution and kinematics of Cepheids in the Milky Way Galaxy

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Cepheids are high-luminosity pulsating giants or supergiants with well-defined dependence between period and luminosity. Given the exact period, this dependence yields the absolute magnitude, and knowing the mean visual magnitude as well, we can easily determine the distance to a Cepheid. This work aims to study the kinematic properties of the Galaxy. To do this, we consider classical Cepheids as test particles in the global velocity field.

Using photometric catalogues and open sources of photometric data, we collected data on all the Cepheids listed in the General Catalogue of Variable Stars. To study an ambiguously classified star V480 Aql we analyzed raw multicolor 2012-2014 observational data.

Taking into account determined period and temperature variations, we identified V480 Aql as a classical Cepheid. While collecting data on period, we improved period values for 46 Cepheids using Lafler-Kinman method. Using renewed data, we calculated the distances to these Cepheids and plotted their 3D distribution. Adding the information on radial velocities and proper motions of 202 Cepheids we determined their velocity vectors and plotted their projections on the Galactic plane.

All of Cepheids appeared to belong to the thin Galactic disk. We estimate that no more than 12.6% of them are available for observations in visual band. The distribution of Cepheids follows the spiral structure of the Galactic disk. The velocities of Cepheids are in good agreement with the rotation curves found in scholarly publications.

### High-frequency variations in hydrogen spectral lines of the B type star Eta UMa

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We carried out a high-speed low-resolution spectroscopic survey of B type star Eta UMa with grism spectrograph. In this paper we reported the discovery of rapid variability in the Balmer lines of hydrogen in the hot star Eta UMa, spectral class B. Spectral observations of Eta UMa, conducted with gapless Grism spectrograph that was set at 60 cm Ritchey-Chretien telescope of Andrushivka Observatory ($R \sim 100$). Spectra were obtained high-resolution subsecond range. It has been found that the hot star Eta UMa has rapid variations present in the hydrogen lines $H\alpha$, $H\beta$, $H\gamma$, as well as variations in atmospheric oxygen lines. Variations in the intensity of the lines is from 1% in the lines of Balmer continuum.

### High-frequency variations of spectral lines in the chromospherically active stars of BY Dra type

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We present the results of high-speed spectroscopic survey of chromospherically active stars. Spectroscopic observations of chromospherically active stars showed variations of intensity in the Balmer lines and the Mg b triplets at time intervals ranging from seconds to several minutes.

Spectral observations of chromospherically active stars was conducted with gapless Grism spectrograph that was set at 60 cm Ritchey-Chretien telescope of Andrushivka Observatory and "Peak Terskol" ($R \sim 100$), and 2-m Cassegrain telescope of Observatory "Peak Terskol" ($R = 13000$). Spectra were obtained high-resolution in subsecond range. These stars are showed to have high-powered chromospheres. Spectrum data showed that relative variations in the $H\alpha$, $H\beta$ lines and the Mg b triplets are about 1% and the relative power of chromospheric activity about $2 \cdot 10^{-4}$.

## Light curve of the dwarf nova V503 Cyg: normal outbursts, super-outburst and their features

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We investigated the light curve of the dwarf nova V503 Cyg during 61 days in 2012. The observations were performed in the R filter with the Crimean Astrophysical Observatory and Apache Point Observatory telescopes. Analyzing the light curve we found out, that periods in the minimum outburst activity before and after the super-outburst (SOB) are different. In addition, we considered the superhumps (SH) behaviour during the SOB.

# EXTRAGALACTIC ASTROPHYSICS

### Rotational curve of spiral galaxy in Stephanie metric

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Acceleration of the Universe can be explained if we consider Einstein's equations with uniform energy and non-uniform pressure. One of these solutions is model for a shiftless perfect fluid. This metric is known as Stephanie metric. We explore the form of rotational curve in dependence on pressure inhomogeneity. Rotational curve shows us an existence of hidden mass, which is called a dark matter. The "dark matter problem" can be partially explained with curvature of space-time.

One of the problems in this question is a transition from initial metric to a system of distant observer (DO). In this work we choose curvatures coordinate system like one of the DO's and build the velocity of rotation dependence on the distance to center.

### Black Holes merging at the centres of interacting galaxies: coalescence time estimation

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We present a set of, state of the art, large scale direct N-body simulations of the galaxy collision with the central Supermassive Black Hole system (SMBH). Each galaxy is represented as a set of particles (up to N = 1M). The SMBH system is described using the two high mass special, i.e. "relativistic", particles. The interaction between these two particles have an extra post-Newtonian correction

terms (PN) up to PN3.5 level. We conclude that our code correctly describes the behavior of the SMBHs mergers in galaxies. The obtained results are quite comparable with simplified method which include only the analytic description of Peters and Mathews (just 2.5PN term). We obtained the merging time upper limit for interacting galaxy NGC 6240, spiral galaxy NGC 3393 and seven SDSS objects.

### The chemical composition of Oxygen and Sulfur in galaxies in the data of the Sloan Digital Sky Survey

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Knowledge of the detailed chemical composition of galaxies is fundamental to our understanding of stellar nucleosynthesis and evolution of galaxies. Emission-line galaxies provide an easy way to determine the abundances of such elements. We have derived oxygen and sulfur element abundances in the emission-line galaxies from the Data of the Sloan Digital Sky Survey (SDSS). SDSS spectra have high quality, and SDSS is considered one of the best ground-based telescopes project. From a visual examination of the spectra and subsequent measurements of emission line fluxes, we extracted $\sim$ 250 spectra with O ans S emission lines well presented. We calculated the electron temperature in selected galaxies and compared their abundances. We confirm previous studies about S and O abundances.

### Analysis of secular light curve of OJ287 quasar

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According to the Valtonen theory (Valtornen et al. 2006), the OJ287 quasar is an interacting system of two black holes, one of which is a supermassive black hole (17 billion solar masses) and the other is intermediate black hole (100 million

solar masses) that revolves around a supermassive black hole with the period of 11.8 years. The aim of our research was: investigation of the secular light curve of OJ287 quasar, a search of periodic phenomena in an outburst quasar activity, photometric monitoring of the quasar using filters (I, R, V, B, U). Analyzing the secular light curve of OJ287, we have proposed a classification of a outburst quasar activity, and single out secular outbursts of the I order (60 year period, 4m amplitude), large outbursts of the II order (11.8 year period, 2.8-3m amplitude ), moderate outbursts of the III order (5 month period, 2m maximum amplitude), micro outbursts of the IV order (40 day period, 0,6m amplitude). With due regard to Valtonen's data, we analyzed the possible causes of various types of outbursts. In particular, the cause of secular outbursts is the orbital evolution of dual orbit caused by precession influence, II order outbursts passing a smaller black hole through accretion disk of supermassive hole, III order tidal interactions in dual model, IV order jet fluctuations caused by the interaction of black holes. Next outbursts time of the I-II orders were predicted. During photometric monitoring of the OJ287 in 2012-2014 at the observing station of the Astronomical Observatory of Kyiv National University (MPC 585), the outbursts of the III and IV order were observed.

## The catalog of morphological types of rich PF galaxy clusters

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The Catalogue of Galaxy Clusters and Groups PF (Panko & Flin, 2006) was constructed for statistical researches of the properties of large-scale structures till redshifts $z < 0.20$. However, the morphological types of galaxy clusters were taken into consideration only for limited subset. The clusters of the subset obtained Bautz-Morgan morphological types from comparison the PF and ACO catalogues.

Our adopted morphological scheme bases on the classical approaches of Abell, Zwicky, Bautzen & Morgan and Rud & Sastry and takes into consideration the next parameters: concentration to the cluster center, the presence of preferential direction or plane and bright galaxies role (Panko, 2013). We assigned the morphological types for 458 rich PF galaxy clusters according to the scheme using the numerical criteria.

We present the Catalogue of morphological types of rich PF galaxy clusters.

# COSMOLOGY & GRAVITATION

### Null solutions of Maxwell equations in Kerr space-time

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Kerr space-time is described by the metric which provided by a rotating star or a black hole. By investigation of gravitating bodies with these properties the problems of scattering by a black hole, superradiance, gravitational lensing and black-hole shadow arise. Solutions of above mentioned problems give to us information which will be compared with observations.

We will present the solution of homogeneous Maxwell equations for null Maxwell spinor in Kerr space-time. By corresponding choice of the principal spinor of Maxwell field and principal spinor of Petrov type D gravitational field we have obtained solution which describes retarded or advanced wave. Obtained solution can be applied to all described wave optic problems.

### Dynamics of dark energy in collapsing halo of dark matter

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In our work we investigate the non-linear evolution of 3-component (dark energy, dark matter and radiation) system of perturbations. The dark energy is presented as perfect fluid with three parameters: the density $\rho_{de}$, the EoS parameter $w$ and effective speed of sound $c_s$. We use conservation equations for every component and Einstein equation for evolution of metric perturbation. We solve them numerically and find the time evolution of density and velocity perturbations of every component and the gravitational potential. Both phantom ($w < -1$) and quintessence ($w > -1$) models of dark energy are studied. The dependence of transfer function of dark matter perturbations on dark energy parameters in such system is also studied.

### Vacuum effects in the presence of a finite thickness magnetic tube

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Vacuum polarization effects in a magnetic cosmic string background are considered. The cosmic string is modeled by finite radius ($r_0$) magnetic-flux-carrying tube that is impenetrable for quantum matter. The vacuum polarization depends on the choice of a boundary condition at the edge of the tube. We impose the Neumann boundary condition at the edge of the tube on the charged massive scalar matter field which is quantized outside the tube.

We find that a current circulates around the string. As a consequence of the Maxwell equation, a magnetic field strength is also induced in the vacuum and it is directed along the cosmic string.

The behavior of the current and the field strength are comprehensively analyzed. Both the current and the field strength decrease exponentially with the distance from the string. In contrast to the model of singular magnetic cosmic string, magnetic field strength is finite at the edge of the string. The limiting case ($r_0 \to 0$) for string with Neumann boundary condition isn't equivalent to the singular magnetic string.

We demonstrate that induced vacuum effects in the model of the finite thickness magnetic tube are substantially larger than in the model of the singular magnetic string.

### 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 Å ($l_{1450}$) and similar spectral index $\alpha_\lambda$ 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 Ly$\alpha$-forest (auto-correlation function and flux power spectrum).

## Reionization in cold, warm, cold+warm dark matter model

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It is known that presence of initial velocities of dark matter particles suppresses structure formation at smallest scales.

Using semianalytical "bubble" model, we study the infuence of initial dark matter velocity distribution in models of cold (CDM), warm (WDM), cold+warm dark matter (CWDM) and decays of DM particles on the process of reionization of the Universe.

Using the 7 keV sterile neutrino CWDM realistic model we study the growth of ionized fraction with time. The reionizatition in these models is completed at $6 \leq z \leq 9$ depending on warm fraction.

The hypothethis of great influence of dark matter decays on reionization isn't confirmed, the influence of DM decays is small. In CDM model reionization is completed at $z \approx 10$.

We show that reionization in WDM and CWDM models starts earlier and completes later (compared to CDM case) which is in better agreement with observations.

### Identification of the optimal object observations to confirm the nature of the line at 3.5 keV

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Over 1000 objects were analyzed and selected TOP20 in view of the value column density for galaxy groups and clusters and TOP20 for types S, E, dSph. We applied NFW and ISO models according to profiles of objects. Next, to assess ratio signal to noise (S/N), which is proportional to $S \cdot \sqrt{t/B}$, where $t$ – is the time of exposition, $B$ – flux of background, using XMM-Newton skymap, we set the $t$ and $B$ for each object with TOP20. Accordingly, good for objects observation are Abell 3526, Abell S239, Abell 1060, also MW, M31, M60, M49, NGC 1399, NGC315 and M33.

# SOLAR PHYSICS & HELIOSPHERE

## Flare and sunspots statistics comparison: investigating flare prediction possibilities

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For better understanding of long-term flare activity dependence on sunspot parameters, we used the statistical study of the flare frequency of occurrence regarding to various sunspot groups indices. Here we used Space Weather Prediction Center NOAA database regarding sunspot group parameters by classes and solar M and X flares registered by geostationary operational environmental satellites (GOES).

As a first step, we investigated the distribution of sunspot groups by their longitudinal extend, conditionally dividing them into 3 categories by area (in millionths of solar hemisphere, msh): the smallest – $S < 140$ msh; intermediate – $140 < S < 420$ msh and the largest – more than 420 msh. It was found, that the largest sunspots' length distribution is well correlated with RI, and can represent solar activity as well. As the biggest and the most complicated sunspot groups produce of flares is more frequent and powerful, we compared flare statistics with largest sunspots and obtained results, that show that X-class flares have a noticeable time lag of approximately 1 year with respect to sunspots' longitudinal extend: linear correlation coefficient for X-class flare number and average sunspot groups' length annual values is $r = 0.42$, but after offsetting length values for the year ahead, it increases to $r = 0.81$. For flare index and average sunspot groups' length annual values these coefficients are $r = 0.6$ and $r = 0.82$. Further research will give more detailed information about flare-sunspot groups parameters statistical rapport and present a possibility for long-term solar flare prediction.

## Dust grain surface potential in a non-Maxwellian dusty plasma with negative ions

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Dust charging processes involving the collection of electrons and positive or negative ions in a non-equilibrium dusty plasma are revisited by employing the power-law kappa ($\kappa$) – distribution function. In this context, the current balance equation is solved to obtain dust grain surface potential in the presence of negative ions. Numerically, it is found that plasma parameters, such as the $\kappa$ spectral index, the negative ion-to-electron temperature ratio ($\gamma$), the negative–positive ion number density ratio ($\alpha$), and the negative ion streaming speed ($U_0$) significantly modify the dust grain potential profiles. In particular, for large kappa values, the dust grain surface potential reduces to the Maxwellian case, and at lower kappa values the magnitude of the negative dust surface potential increases. An increase in $\gamma$ and $U_0$ leads to the enhancement of the magnitude of the dust grain surface potential, while $\alpha$ leads to an opposite effect. The relevance of present results to low-temperature laboratory plasmas is discussed.

### Transfer processes in the transition layer of solar wind and the Earth's magnetosphere

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Solar wind and magnetosphere interaction are not a simple additive phenomenon on magnetosphere and solar wind fluctuations, but a complex, nonlinear system. There is a catastrophic alteration of flow and magnetic topology (rapid and slow jets, transition from laminar region to irregular boundary structures etc.). Relation on a pre-history (on a characteristic Alfven flow times); abnormally great correlations on large temporal and spatial scales; formation of coherent structures in the form of jets that provide an abnormal transfer of plasma – this is not a complete list of events taking place in transition regions of the Earth's magnetosphere. The type of diffusion processes are unknown not only in the region, which characterized by great variability of magneto-hydrodynamic parameters, but also in the quieter areas of the solar wind.

We have done the estimation of diffusion processes in the transition region of the magnetosphere and solar wind.

Variation of the total magnetic fields was investigated, based on the flux-gate magnetometer measurement from C1 satellite of "Cluster 2" space mission, with a 22.5 Hz temporal resolution.

Determining the type of diffusion processes carried out in two ways – from the analysis of evolution of the probability density fluctuations of the magnetic field maximal height, and using the parameters of the log-Poisson model.

Among the results, obtained one can note the presence of super-diffusion processes in the transition region of the magnetosphere of the Earth.

These results allow to qualitatively and quantitatively describing transport processes in the studied areas.

The work is done in the frame of complex program of the National Academy of Sciences of Ukraine on space researches for 2012–2016 and within the framework of the educational program №2201250 "Education, Training of students, PhD students, scientific and pedagogical staff abroad" launched by the Ministry of Education and Science of Ukraine.

## The model of galactic cosmic rays distribution near the Earth's orbit under the interaction with quasi-stationary stream of fast solar wind

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The modulation of galactic cosmic rays (GCR) caused by recurrent high-speed solar wind streams in the closed heliospheric model is studied. We propose a model where the heliosphere is considered as a spherically-symmetrical medium that is limited by the heliopause, and the GCR propagate inside it until they reach relative to the Sun spherically-symmetric region (corona). It is accepted that the GCR are elastically scattered by the magnetic fields of the quasi-stationary stream of fast solar wind, which is characterized by a constant speed and scattering properties of the medium. Region of the heliosphere outside the stream is also characterized by a constant values of the diffusion coefficient and solar wind velocity, but such that are different from the values within the flow. It is considered that in this region GCR are absorbed at the boundary of corona due to the interaction with coronal matter.

Based on the proposed model, there are obtained the distributions of GCR intensity for rigidity $\sim 10$ GV near the Earth's orbit in different phases of solar activity. It is shown that the model computation is confirmed by experimental results that have been obtained from statistical analysis of neutron monitors data for the 2000 – 2014 years.

### Main features of Forbush effects caused by various sources of solar wind disturbances

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There was studied the influence of quasi-stationary and sporadic streams of the fast solar wind on the intensity of galactic cosmic rays near the Earth's orbit based on statistical analysis of data from the neutron monitor worldwide network for the period of 1960 – 2014 years. More than two thousand of Forbush effects were divided into two groups depending on the modulation source (coronal holes or coronal mass ejections). The dependence of magnitude and other characteristics of Forbush effects on various parameters of the interplanetary disturbances, indices of solar and geomagnetic activity has been studied for the selected groups.

### Magnetic field diagnostics in solar faculae using BSF method

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The bisectors of $I \pm V$ Stokes profiles were analyzed for diagnostics of local magnetic field in solar faculae of 7 August 2013 observed on Echelle spectrograph of horizontal solar telescope of the Astronomical Observatory of Taras Shevchenko National University of Kyiv. The main idea of bisector splitting function (BSF) metod is to analyze the weak deviation of observed splitting of bisectors of $I \pm V$ profiles from linear trend taking into account that in case of weak field approximation the bisectors of $I + V$ and $I - V$ profiles should be mutually parallel (Lozitsky, 2015). This method was applied to observations in FeI 5233 line. We found a weak spectral peculiarity on distance nearly 120 mÅ from line center that could indicate the presence of local magnetic field of about 7.4 kG.

# ATMOSPHERIC STUDIES & SPACE GEOPHYSICS

### Propagation of planetary electromagnetic waves and atmospheric-gravitational waves in the Earth's ionosphere, theory and modeling

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During the oral presentation I will tell about method of analyzing of planetary electromagnetic waves (PEMW) in the Earth's ionosphere, their excitation and propagation. There was derived the system of MHD-equations without beta-plane approximation and was built model distributions of the velocity of the air of ultra-low frequency atmospheric-gravitational waves (AGW) on different heights for double-frequency transform. Also was observed the response derivation of artificial perturbation on the ionosphere, which is equal to natural.

### Improving troposphere ozone height profiles by combined FTIR and Umkehr methods

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Simultaneous ground-based Fourier Transform Infrared spectrometer (FTIR) and Umkehr Dobson spectrophotometer ozone profile observations have been provided for development of the methods for study tropospheric ozone altutude distribution. Observations were performed in cloud free and clear sky conditions in

the wide range of solar zenith angles. Total ozone column and ozone profile data were obtained from Direct Sun and Umkehr series measurements with the Dobson spectrophotometer 040 at the GAW station №498 Kyiv-Goloseyev simultaneously with FTIR observations at the same site. The GAW station Kyiv-Goloseyev is located at the Main Astronomical Observatory of National Academy of Sciences of Ukraine. The spectral modeling of the FTIR measurements ozone spectral band profile near 9.6 microns with the MODTRAN4 model based on the HITRAN-2001 molecular absorption database have been provided. The total ozone column values retrieved from FTIR observations were compared with OMI satellite instrument data and Dobson measurements. The results are consistent within 20 DU. For the retrieval of ozone column values and modeled ozone profiles from FTIR observations, the satellite Aqua-AIRS water vapor and temperature profiles for the data of observations have been used. The stratospheric ozone profiles for FTIR modelling have been obtained from our Umkehr Dobson measurements (heights 13-45 km). The surface ozone concentration was used from the 49i – O3 Analyzer ozonometer measurements at the same site. The preliminary analysis of improved troposphere ozone profiles retrieved from FTIR spectra using Umkehr stratospheric profiles are provided. The seasonal features of Umkehr ozone profiles are discussed in the report as well.

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## Spatio-temporal features of stratosphere ozone distribution over Ukraine by 1979–2014 satellite data

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The spatio-temporal distribution of the total ozone column (TOC) over the territory of Ukraine (43.5°N – 52.2°N, 22°E – 42°E) has been analyzed in the report. Short-term and long-period changes of TOC values are based on satellite observations of total ozone column by satellite spectrometers TOMS and OMI, during the last three decades (1979–2014). The maximum of TOC values for a short-period changes are observed in spring (March – April), minimum - in autumn

(October – November). Decreases of the total ozone (trend) at the beginning of 21th relative to the end of 20th century correspond to long-period changes in TOC values. The heterogeneity of spatial distribution of total ozone observed as well with at the decrease of TOC in the direction from north-east to south-west of Ukraine.

Acknowledgements. The work was supported by the project PICS 2013–2015 of CNRS France and the National Academy of Sciences of Ukraine.

## Statistical analysis of the transition processes in the Earth's magnetosheath

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Magnetosheath – the region between the solar wind bow shock and Earth's magnetosphere plays an important role in the physics of the inner magnetosphere. Statistical studying of magnetosheath reveals major processes in this region. The magnetosheath region physics includes various phenomena's, including diffusion processes, variety of wave types, cascade process and other non-linear aspects of solar wind and Earth's magnetosphere interaction.

We investigate the complex spatial structure of cascade processes, by studying the 3D structure of the "Cluster 2" mission, with 22.5 Hz temporal resolution of magnetic data.

We apply the statistical methods to distinguish the main processes in magnethosheath and find their main characteristics based on their type.

We use the relevant data for periods when the mission orbit traversed the magnetosheath (1st May 2013 and 11th May 2014).

The high pass wavelet filter was used to found the cascade processes and reverse cascade processes, the main characteristics: main frequency, amplitude and characteristic time is presented in this work.

The work is done in the frame of complex program of the National Academy of Sciences of Ukraine on space researches for 2012-2016 and within the framework of the educational program №2201250 "Education, Training of students, PhD students, scientific and pedagogical staff abroad" launched by the Ministry of Education and Science of Ukraine.

**The ozone mini-holes and antymini-holes in stratosphere over Kyiv during 2010-2015**

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Ozone mini-hole is determined as a short-term (several days) sharp decline in total ozone column (TOC) in local areas stratosphere. Ozone mini-holes are seen especially as variations in daily values TOC during winter-spring peak. Unlike the Antarctic ozone hole where reduction of TOC caused mostly by chemical destruction of ozone, mid-latitudes mini-holes associated with the influence of tropospheric dynamic processes – horizontal and vertical flow of air masses at altitudes near tropopause and lower stratosphere. Except mini-hole, the opposite phenomenon exists – antymini-hole, areas where ozone concentration is much higher. In this work, the standard WMO observations of ozone were provided using Dobson 040 spectrophotometer by measuring the absorbtion intensity of solar radiation in the near ultraviolet range (305–340 nm). Besides measurements by spectrophotometer, the study of the ozone behavior over Kyiv site using the data obtained for the last 4 years has been made. Ozone Kyiv site data have been compared with ozone satellite data and regional weather conditions. The cases of mini-hole and antimini-hole were identified over Kyiv site area. The discussion of the results together with weather pattern by Sat24 website and ozone movement by the TEMIS (Tropospheric Emission Monitoring Internet Service) ozone data was performed.

# HIGH-ENERGY ASTROPHYSICS

### Characterization of lead titanate thin films prepared by Sol gel process

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Ferroelectric materials are of high interest for a numerous applications, including non-volatile memories, dynamic random access memories, electro optic switches, pyroelectric detectors, etc. and considerable attention has recently focused on the development of the technology for their growth in thin films.

Lead titanate (PbTiO3) PT sol–gel derived thin films have been prepared on glace substrates using lead acetate trihydrate, and titanium isopropoxide as precursors along with 2-methoxyethanol as solvent and acetic acid as catalyst by spin coating method. Techniques including X-ray diffraction (XRD), scanning electron microscopy (SEM), electrical and ferroelectric hysteresis measurements have been performed for layer characterization.

### Multiwavelength observations of the binary system PSR B1259-63/LS 2883 around the 2014 periastron passage

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In the PSR B1259-63/LS 2883 system, the millisecond (48 ms) pulsar (PSR B1259-63) is in a highly eccentric orbit around a massive Be star, LS 2883. Be star is characterized by a slow dense disk-like outflow of stellar material in the equatorial plane along with the fast diluted polar wind. In PSR B1259-63 the disk is inclined to the orbital plane, so that during the periastron passage pulsar crosses the disk twice. Interaction of the relativistic pulsar wind with the non-relativistic companion outflow leads to the broadband radiation visible from radio up to very high (TeV) energies. Throughout the orbit, different energy loss mechanisms – synchrotron radiation, Inverse Compton scattering and adiabatic losses caused by the expansion of pulsar wind against the external pressure – lead to the observed

emission and provide a fascinating laboratory to study pulsar winds and pulsar wind interactions.

Despite quite intensive X-ray and radio observations it was not possible to unambiguously determine the energy of the relativistic particles of the pulsar wind. Fermi observations were thought to solve the puzzle. Indeed, observations around the periastron passage were inline with the theoretical predictions supporting moderate energy ($\gamma \sim 50$) of the relativistic electrons. However a month after the periastron passage a spectacular flare, not predicted by any theory, has been detected. In my report I would like to present results of our X-ray (Suzaku, Swift) and GeV (Fermi/LAT) data analysis and discuss the general multiwavelength properties of the source, and in particular the possible origin of this flare.

### The MF Strength Estimation from the Nonthermal X-ray Radial Profiles of Tycho SNR

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We use nonthermal X-ray images of Tycho SNR in order to estimate the magnetic field strength in the vicinity of the Tycho SNR.

The radiative losses of the relativistic electrons depend on its energy and MF strength. The idea of the method is that the stronger the magnetic field, the larger the electron radiative energy losses. As consequence the spatial distribution of electrons behind the shock decreases rapidly and a sharp maximum in the radial X-ray brightness profile is formed. On the observational data it is reflected by the fact that the thinner the rim in X-rays the stronger the MF is expected to be.

We calculated a number of theoretical X-ray profiles for a wide range of MF strength values and compared them to the experimental profiles for a number of regions close to the shock wave position.

### Study of TeV blazar Mrk 421 with the Cherenkov Telescope FACT

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One of the most bright TeV-blazars is Markarian 421 (Mrk 421, $z = 0.031$). Since the discovery of TeV gamma-radiation from Mrk 421, this source is a subject of intense research in this spectral range. Mrk 421 demonstrates variability, including extremely rapid (shorter than 30 minutes) flares. The origin of these flares is yet not clear. For this reason, the observations of this object can reveal the physical processes during flares.

We present the results of observations of blazar Mrk 421 with Cherenkov telescope FACT (First G-APD Cherenkov Telescope, La-Palma, Canary Islands) for the period November 28, 2013 – June 1, 2014. Using the specific software, we selected the observational data, made some corrections, and formed the list of gamma-ray events. The data analysis was performed, involving the new energy calibration for the FACT Cherenkov telescope. This enabled us to get more accurate values of energy of registered gamma-rays. Based on the processed data we built the spectrum and light curve of Mrk 421 in TeV energy range for the specified period. Analyzing the obtained spectrum we identified its main properties and found out the mechanism that is responsible for spectrum formation, with several additional effects. Also we studied the spectral index variation with time. The light curve of the source contains the strong flare, that occurred in 2014. We processed short-time observational data, collected during the outburst, calculated the relative flux enhancement, the spectrum of the flare and compared it with the average spectrum. The blazar active state features indicate that it is the most powerful flare in the history of Mrk 421 observations.

## Search for the sources of the ultra high energy cosmic rays with energies above $10^{20}$eV

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We are looking for the potential sources of the cosmic rays with energies above $10^{20}$eV taking into account the deflection of ultra high energy cosmic ray (UHECR) trajectories in the Galactic and intergalactic magnetic fields. At the map of the arrival directions of the UHECRs there are some indications on the possible point like sources, connected with the "hot spot" ($l = 177.14$, $b = 49.59$) in Telescope Array data, the triplet ($l = 34.97$, $b = -3.88$) in TA (two events) and PAO (one event) data and the famous highest energy event $E = 10^{20.5}$eV ($l = 162.19$, $b = 7.56$) in Fly's Eye data. We consider the possible both Galactic and extragalactic sources of these events and estimate chemical composition and acceletation mechanism in each case.

### Determination of Astro-H sensitivity with respect to the unidentified line at 3.5 keV

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In 2014, a new line with energy 3.5 keV was detected in X-ray spectra of galaxy clusters, Andromeda galaxy and the central part of the Milky Way. Its properties are strikingly consistent with that of decaying dark matter, although its explanation due to strongly enhanced abundance of potassium is also possible. Further determination of line origin needs much more precise angular resolution that that of existing imaging spectrometers (such as XMM-Newton/EPIC, Chandra/ACIS and Suzaku/XIS). At the end of 2015, the new X-ray mission Astro-H is planned to launch. Its spectrometer SXS will have energy resolution about 7 eV, an order of magnitude better than that of existing spectrometers. It is therefore crucial to determine the best targets to determine the line origin, and Astro-H/SXS exposures necessary for such determination. For making this, we created simulations of Astro-H observations using background files, which were made in laboratories on the Earth. We studied the central parts of the Milky Way and Andromeda galaxies, compared the significance and signal-to-noise ratio as function of observation time and determined that a 2-3 Msec Astro-H/SXS observation of the Galactic Center – our preferred target – will be enough to detect the new line.

### Synchrotron radiation from the bow shock around the magnetosphere of superconducting cosmic string

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As it is predicted in framework of standard model of particle physics by Kibble mechanism and remains valid for most of alternative particle physics models, there might exist linear topological defects formed in the early Universe – cosmic strings. Detection of cosmic strings is one of the main challenges of observational

cosmology nowadays. In our work we suggest that recently discovered fast radio bursts (FRB), whose nature is still unknown, can be caused by superconducting cosmic strings. In our model we consider a superconducting cosmic string with a cusp, that moves through the magnetic field frozen in cosmic plasma. Induced by magnetic field string current generates string magnetosphere and relativistic velocity of string in magnetized intergalactic medium (IGM) results in a relativistic bow shock around the magnetosphere. Accelerated at the shock by the Fermi mechanism relativistic electrons generate synchrotron radiation with maximum frequencies in GHz region. It is shown that the characteristics of a single FRB event (the fluence at observed frequency, the duration and typical redshift) could be explained by synchrotron radiation of particles from a near-cusp region of superconducting cosmic string magnetosphere. But proposed mechanism can't produce the rate of bursts, that is predicted by observations. We also discuss the properties of radiation from a cusps that can help to distinguish cosmic strings from other possible astrophysical sources of FRB.

### A model of X-ray emission of Seyfert 1 galaxies

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Among other AGN types Seyfert 1 galaxies are quite numerous and bright in X-ray band, so they are the most enable for explanation their high energy emission and structure. The spectra of Sy 1 galaxies can be considered as the emission of accretion disk, similar to quasars but less luminous. The main observable parameters of extragalactic X-ray sources are luminosity and spectral index. Some galaxies has iron line, thermal emission and multicomponent power law continuum. On the other hand, the main internal parameters of AGNs are black hole mass and spin, accretion rate, size and shape of accretion disc and torus, distribution and structure of reflecting clouds. All these parameters can not be find precisely and even their approximate estimation is very hard. In this work we discuss possible correlation between X-ray spectral properties and AGN parameters for Seyfert 1 galaxies. We selected 42 Sy 1 galaxies from XMM-Newton observations archive and analyzed their spectra. The distribution of X-ray luminosities and spectral indexes is discussed. 11 new X-ray spectra of Sy 1 galaxies were obtained and included into the general consideration.

## Using the methods of wavelet analysis and singular spectrum analysis in the study of radio sources SOURCES 3C345, OJ 287, CTA102 and 3C446

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We investigated the monitoring data of extragalactic sources 3C345, OJ287, CTA 102 and 3C446. This monitoring was held on 26-meter radio telescope of University of Michigan at frequencies of 14.5, 8 and 4.8 GHz. To study flux density of extragalactic sources the wavelet analysis was used. Calculating the integral wavelet spectra allowed revealing long-term components ($\sim 16-5$ years) and short-term components ($\sim 0.5-4$ years) in radio sources. The data of radio astronomy observations were also investigated using singular spectrum analysis. This method can solve the task of allocating trend, detection of periodic components and band-pass filtering (reconstruction of time series from quantity of principal components, the last correspond to individual bands of periods on time-frequency spectra or Fourier spectra). Singular spectrum analysis does not use the analyzing function, so its calculations allow to distinguish various components of investigated series with a high accuracy. To get spectral power distribution with time in the studied narrowband components obtained by singular spectrum analysis, short-term Fourier transformation was used.

These data were compared with VLBI radio maps, which were obtained by the program Mojave. Studying of radio maps allowed investigating features of components moving relative to the VLBI core.

## The optical afterglow of gamma-ray burst GRB130427A

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During our investigation of the flow GRB 130427A was the brightest flash among all of the detected gamma-flashes. It is the result of its relative closeness. By the results of our investigations, which were held during 8 nights in April and May of 2013 on the 70-cm reflector of Chuguev observation station of Institute of astronomy of Kharkiv National University, we have built a curve of the glow GRB130427A in the stripe SDSS r. We have made a research of data, that was observed in other observatories, in the base of GCN, in order to make their comparative analysis and to build a full light curve of afterglow. From the analysis of the dependence of density of the radiation of the flow from the time we distinguished 6 different zones with different tilts with values between $-0.76$ and $-1.14$.

## Analysis of spatial and temporal and spatial properties of object near Centaurus A

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The temporal properties of some objects near the radio galaxy Centaurus A were investigated. The data from Chandra X-ray telescope were used. The variability of some observations was found by p-method and the method of Gregory-Loredo. Provided that such variability is periodic, possible period was calculated. It is expected that the investigation covers additional modulation amplitude, we see no pulses with small amplitude, as variables. It was concluded that the object is X-ray burster. The model of the researched object and X-ray flashes were compared.

## Fast radio bursts as electromagnetic radiation from cusps on superconducting cosmic strings

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During the last decade a new class of objects, that received the name of fast radio bursts, was discovered by the Parkes telescope and the Arecibo observatory. There are 10 observed fast radio burst at the moment. All of them have similar characteristics: the frequency of detecting is 1.3 $GHz$ and 1.4 $GHz$, the duration is near a few milliseconds and the peak of observed peak flow is near a few $Jy$.

There exist several alternative theories, that trying to explain this phenomena, but we propose to consider fast radio bursts as a electromagnetic emission from the cusps of superconducting cosmic strings, that moves with the large Lorentz-factor through magnetic field, frozen into the cosmic plasma. The radiation flux is periodic, highly beamed and has the nature of a burst. Significant collimation decreases possibility of observing of a single phenomenon from the Earth, even so collimation effects are compensated for number of parameters by great number of loops in a region accessible for observations.

In the present work characteristics of 10 fast radio bursts, discovered till now, are studied. Also, main characteristics of cosmic strings, which can serve as a source of these bursts, are explored. Under the assumption of average loop's length, it is found energy characteristic of string $\alpha = \Gamma G\mu/c^2$, that related with energy of phase transition, during which these strings were created. The values of the parameter $\alpha$ are given for two magnitudes of the magnetic field, wherein superconducting string loop moves – $B_0 = 10^{-10}$ $G$ and $B_0 = 10^{-8}$ $G$, and also for two variants of comic string's emitting region scale – classical $l/\gamma_s$ and more conservative one $l/\gamma_s^2$.

For the variant, that seems the most realistic – magnetic field $B_0 = 10^{-10}G$ and squire-inverse dependence of emitting region scale from Lorentz-factor of cusp, we received the value $\alpha \sim 10^{-12} - 10^{-11}$, that responds energy scale of phase transition $\eta \sim 1.7 \cdot 10^{12} - 5.5 \cdot 10^{12}$ $GeV$.

In the framework of emission from cusps of superconducting cosmic string loops, we also estimated probability of FRB detecting, that is highly close to probability of detecting, given by observational data.

Radiation from cusps of superconducting cosmic strings could also be enhanced by non-thermal emission of electrons of cosmic plasma accelerated on the shock wave front around near-cusp region of a string.

# SOLAR SYSTEM & EXOPLANETS

### An approximate measurement of the love numbers and tidal effects of Neptune on Triton

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Triton is Neptune's largest moon, and the 7th largest satellite in our solar system. Our current information with regards to the physical parameters on Triton come from the Voyager 2 flyby in 1989, and due to its large distance from the sun, the collection of further data through ground based and low Earth orbit based observations has been difficult. A possible procedure to reach inferences about the internal composition and structure of Triton is to measure its Love numbers and the displacement of its tidal bulge due to its proximity to Neptune. In this project, an analytical approach using numerically simplified expressions for the tidal Love numbers $h$ and $k$ are used to gain a physical understanding about the internal structure of Triton. The calculations are carried out for varying internal densities for the core and mantle, followed by further calculations to determine the nature of tides an the satellite surface in its early days, when its orbit around Neptune is presumed to have been more eccentric. The Love numbers on Triton can also give an insight as to whether there is a subterranean ocean underneath its surface, and if so, the depth and extent of it.

### Dependence of the YORP effect on the asteroid shape

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Our talk is devoted to Yarkovsky–O'Keefe–Radzievskii–Paddack effect (or YORP effect for short). This phenomenon means changing of an asteroid spin due to pressure of reinsolated light from irregular and rough suface of the asteroid. We want to discuss how to assess the sensetivity of the YORP effect to different scales of irragularity and roughness of the asteroid surface. Considered is the problem of analytical calculation of the YORP effect for slightly asymmetric

bodies. The asteroid is modelled as a sphere perturbed by spherical harmonics and stretched along three mutually orthogonal axes. This streching allows to get the YORP effect in the first order in terms of spherical functions, in contrast to other approaches where it was the second-order effect. The contribution of different spherical harmonics to the YORP effect is studied as a function of the asteroid's elongation. Some harmonics appear to give vanishing contributions to the YORP effect due to symmetries, while among the others the largest contribution is provided by harmonic $Y_{42}$. The results can be used to calculate the YORP effect for bodies with known shapes, and to analyze the sensitivity of the YORP effect to minor perturbations of the asteroid's shape.

### Photometric and spectral investigation of the comet 103P/Hartley-2

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The results of photometric and spectral analysis of comet 103P/Hartley-2 are presented. The observations of the comet were made on 13, 14, and 15 November 2010, when it was at the heliocentric and geocentric distances of 1.08 AU and 0.2 AU, respectively. The calculated $Af\rho$ parameter, approximately 100 cm, was used to estimate the dust production rate. Analysis of the spectrum with $\lambda$=3600-7200 Å of comet was carried out. Emission features of the $C_2$, $C_3$, CN species in the cometary coma were identified.

### Delivery of organic material and water to planets through asteroid impacts

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We are creating a dynamical model of today's Asteroid Main Belt using the measured albedo distribution (WISE catalog). We want to focus on studying the delivery of parent bodies of carbonaceous chondrites (C-class asteroids) from the main belt to Earth and to other planetary surfaces. The important point that the future model should be done for present state of Solar System. In doing so, we take direct account of the asteroid main belt's observed dynamical and physical structure and we can validate our model. We plan to use our model to calculate improved water delivery rates across the Solar System and in exoplanetary systems. As the final step we want to study the role of exo-asteroids in the delivery of water and organics to exo-Earths.

## Research activities centaur Echeclus 174P using the methods of photometry

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Centaurs – it's icy bodies in the Solar system that interact with the giant planets. They have orbital perihelion and the axis between the orbits of Jupiter (5.2 AU) and Neptune (30 AU), and are not in resonance $1:1$ average motion of any planet.

They are the Kuiper Belt asteroids, but being a long time in conditions of weak solar radiation and low temperatures, getting into the inner regions of the solar system, showing physical activity at distances greater than 5 AU about the Sun, similar to the comet.

Taken data – 174P photometric images that were obtained through extensive filter in Andrushivka's Observatory. He was counted sky background and the signal from comets and stars from the standard was defined by aperture photometry for each filter V and R. All images were corrected for flat field with photo of morning sky.

Found profiles of surface brightness of the comet. Obtained pictures indicate the presence of places around 174P.

Radial profiles were used in order to assess the level of physical activity and comets dust activity of its core. To do this, we calculated the value $Af\rho$.

Research active Centaurs provides valuable experimental data for the study of signs and physical activity at large heliocentric distances. This allows to identify the composition of primordial matter and conditions of condensation in the formation of small bodies in the early stages of the Solar system.

### Analysis of self-gravitating satellites of the planets in the Solar system

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In the Solar system today open more than 180 satellites of the planets, and the number of outdoor satellites continues to grow with the development of technology, but most of these satellites have insufficient weight and keep their shape only through the strength of the electromagnetic interaction. The purpose of this paper is to analyze the physical properties of planetary satellites. The analysis of planetary satellites as self-gravitating structures, i.e. those which are due to its own weight and the resulting gravitational forces hold their shape and seek to bring it closer to equilibrium.

### 14P/Wolf, 15P/Finlay, 16P/Brooks 2 and 21P/Giacobini-Zinner comets' disintegration study

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The secular disintegration of absolute magnitude for 4 short-period comets (14P/Wolf, 15P/Finlay, 16P/Brooks and 21P/Giacobini-Zinner) are studied. For the whole period of observations (129 years) comet 14P disintegrated by 7.5m, comet 15P (128 years) – by 1.6m, comet 16P (128 years) – by 3.3m. For comet 21P (112 years) the apparent disintegration is not found. So, two groups of comets with the apparent disintegration (decrease of absolute magnitude for 100-200 years is 1–4m) and implicit disintegration (decrease of absolute magnitude is less then 0,1m) was established. The first group includes comets 14P, 15P, 16P, second – 21P. The connection of the disintegration of comets with secular variations in solar activity was revealed.

## Ejecta deposits of Copernicus crater

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The crater Copernicus, 96 km in size, is located on the lunar near side. It is a bright, young crater, $\sim$ 779 (Hiesinger et al., 2012). The crater is optically heterogeneous. There is an amazing feature in the left upper quadrant of the crater, which is very well detected in color-ratio (red/blue) images. This very red feature was discovered many years ago by (Whitaker, 1969). Its unusual color results from a spectrum characterized by strong ultraviolet absorption. Besides this crater, there are several very red formations (Malin, 1974) attributed to pre-mare material with unusual composition. A portion of such red spots could be surface manifestations of pre-mare basalts (Malin, 1974; Hawke, 2002). Examples of red spots are the formation Helmet and Riffaeus Montes. These formations, perhaps, are rhyolite extrusions.

We study the crater Copernicus and its ejecta blanket near the rim, primarily using optical data, to confirm the hypothesis that the Copernicus red spot is a residual of a rhyolite extrusion that was involved in the impact formation process of the crater. The rhyolite material could be partially melted, crushed, and ejected to the crater vicinity. The described asymmetry of the red ejecta can be related to the eccentricity, relative to the extrusion, of the impact and a to tilt trajectory of the impactor.

Clementine mosaics (McEwen & Robinson, 1997) and LROC WAC data are used for the analysis as source data. We also apply Lucey's (Lucey, 1998) and LSCC (Lunar Sample Characterization Consortium) (Pieters, 2006) approaches to assess chemical/mineral composition of the studied area.

We demonstrate that the red asymmetry probably was not formed during the evolution of the lunar surface. We find several confirmations of the hypothesis that the Copernicus red spot may be a residual of a rhyolite extrusion that was involved in the impact process, in particular, in target material melting. The rhyolite body could be partially melted, crushed, and ejected to the crater north-western vicinity. The described asymmetry of the ejecta can be related to the eccentricity, relative to the extrusion, of the impact and a tilt trajectory of the impactor.

### Polarimetry of saturnian satellite Rhea

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We present results of polarimetric observations of Saturn's moon Rhea carried out in March 23, 2012 – May 2, 2014 in WR spectral band (550–750 nm). We used 2.6-m telescope equipped with a one-channel photoelectric photometer-polarimeter (Crimean Astrophysical Observatory). The phase-angle dependence of linear polarization of Rhea was obtained using the results of our observations. Results obtained are discussed in terms of existing models of light scattering by regolith surfaces.

### A possible physical mechanism of meteor flares

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Among the unresolved problems which associated with the meteoric phenomena, the question of the mechanism and cause of meteor outbursts are occupied the important place. In many works the emergence of meteor flares is associated with mechanical processes, which are accompanied a meteor during its flight in the Earth's atmosphere. V. A. Bronshten in his "Physics of meteoric phenomena", making a list of some models of meteoroids fragmentation that cause flashes: the simultaneous separation of many small particles (Smith's model), the discharge of the outer layer under the action of the vapor pressure of volatile substances, the discharge of the molten layer under the influence of aerodynamic forces, the foaming of the melted layer, fragmentation the liquid drop of melted meteoroid. However, these models explain this phenomenon only in a part. I. S. Astapovich in his "Meteoric Phenomena in the Earth's atmosphere", concludes that the cause of the outburst is the meteoric itself and is determined by the evaporation of the superheated low-melting inclusions in a nonuniform meteor body. But it is a need to develop a unified model of meteor flares, which would be considered all part of the phenomenon.

Currently, there are new hypotheses concerning this issue. The meteor flares are examined as a result of plasma processes which have place in the meteoric

phenomena. V. A. Smirnov in "The Nature of meteor outbursts", proposes to consider a mechanism of meteors radiation emission similar to the gasdynamic laser. However, we assume that a model which would be more displayed the mechanism of formation flares of meteor, we can consider the process of maser radiation.

When a meteoroid with a velocity of 60 km/s enters the Earth's atmosphere, its interaction with air molecules, which leads to heating of the meteoric body to very high temperatures, it begins to melt and evaporate. Meteoric phenomena are observed in the Earth's atmosphere at altitudes from an average of 100 to 80 km. The atmosphere within this height may be considered in thermodynamic equilibrium, but the interaction with evaporated meteoroid particles, which have a certain kinetic energy, the neutral atoms and molecules of air moving into the excited state and begin to radiate. Assuming that the energy of the particles of meteoric bodies which have evaporated, enough to create a population inversion of levels in the atoms of air, as a result we can obtain a radiation, similar to the maser emission. In the maser amplification of the radiation is due to multiple reflections from the mirrors. In the atmosphere such as mirrors can serve water molecules. Since in the above-described process, which is characterized by short duration of time, taking part at the same time a large number of interacting particles, we observe a momentary flash of light.

Our assuming is quality. We must also do a number of quantitative calculations to confirm or refute this assumption.

## Effect of nonsphericity of gravitational field of the asteroid on the its satellites orbits evolution

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In this work, we investigated double and multiple Near-Earth asteroid systems: (1862) Apollo, (66391) 1999KW4, (136617) 1994CC, (175706) 1996FG3, (276049) 2002CE26. For these asteroid systems second zonal harmonic of gravitational potential was determined for the central bodies and for its satellites. This allows us to take into account second zonal harmonic of gravitational potential for asteroid satellites orbits investigations.

Using computer modeling, we get changes in the Kepler orbital elements in a time interval 17 000 years.

The differential equations of celestial motion are solved by numerical integration using the Everkhart's method in the Cartesian coordinates (Escobal, 1965).

The precision of the equations of motion integration of asteroid systems also was been determined.

As the result of this work we have received changes of the orbital elements of asteroids satellites with the nonspherical central body of the asteroid system.

## Observations of near-Earth asteroids at Lisnyky and Terskol from 2013 to 2015

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We report the results of follow-up studies of some near-Earth asteroids, which were observed at the Terskol Observatory (the Northern Caucasus) and at the Kyiv Comet Station (Lisnyky) during their close approaches to the Earth. The telescopes Zeiss-600 and AZT-8 provide good enough opportunities for precise astrometry and photometry of these objects. During the years 2013–2015, positions of more than 50 NEAs were detected; an accuracy of better than $0.5''$ (on average $0.2''$–$0.3''$ in R filter) was achieved.

Astrometric data acquired have been routed to the IAU Minor Planet Center for analysis. High-accuracy photometry has been used to determine physical characteristics of objects; for a number of asteroids, lightcurve amplitudes and rotation periods were derived.

The program on NEAs observations runs in the framework of the joint research project "Physical and dynamic properties of small Solar System bodies" (№0114U003875). Moreover, observations of potentially hazardous asteroids 99942 Apophis, 2013 TV135 and 2014 HQ124 were performed on alert within the Gaia-Fun-SSO network.

### Spectral investigation of long-periodic comet C/2014 Q2 (Lovejoy)

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We present results of observations and investigations of long-periodic comet C/2014 Q2 (Lovejoy) with the help of optical spectra with middle resolution ($\lambda/\Delta\lambda \approx 1200$). Spectra were obtained with the help of the AZT-14A ($D = 0.48$ m, $F = 7.7$ m) telescope equiped with ASP-9 spectrograf on the observational station of Astronomical observatory of Taras Shevchenko National University of Kyiv in Lisnyky (MPC code 585). Heliocentric distance to the comet C/2014 Q2 at the moment of observations is $r = 1.30$ a.u., geocentric distance – $\Delta = 0.95$ a.u., comet's integral stellar magnitude $T = 5.5^m$, elongation angle $S - O - T = 84°$, phase angle $S - T - O = 49°$.

Based on obtained data we identify emission spectral lines. Also we have obtained some physical parameters of neutral gaseous (using Shulman and Hazer models) and dust comet atmosphere. Distributions of integral and reflected energy along spectrograf's slot were build. Fluxes, number of moleculs, gas productivity for main molecular emisiions and relative dust productivity and spectrophotometric gradient were calculated. This work has been partially supported by the research project №0114U003875.

### Chromospheric activity of stars in systems with exoplanets based on photometric observational data

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This work represents result of processing and analysing of photometrical data observed – for non-transitive star systems HD168746, HD219828. The purpose of the photometric data analysis was to find chromospheric activity indicators, namely the periodicities in the phase of the light curves from data obtained in the broadband filters B and R of Johnson system, which are in the range of powerful chromospheric lines CaII H & K and H$\alpha$. Observational data used in the work were obtained by employees of the Planetary Systems Physics Department of Main Astronomical Observatory.

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