

TARAS SHEVCHENKO NATIONAL UNIVERSITY OF KYIV
DEPARTMENT OF ASTRONOMY AND SPACE PHYSICS

26th Young Scientists' Conference
on Astronomy and Space Physics
Abstracts

Kyiv, 2019

26th Young Scientists' Conference on Astronomy and Space Physics

April 22 – 27, 2019

Kyiv, Ukraine

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26th Young Scientists' Conference on Astronomy and Space Physics

Preface

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

Young Scientists' Conference has a long history. The first meeting was organized by Faculty of Physics of KNU as a students' conference in 1994. Since 1996 our conference has welcomed young researchers from other universities and scientific institutions. During 1994-2018 participants from Ukraine, Russia, Poland, France, Germany, Spain, Sweden, Chile, Libya, Egypt, Japan, Finland, Turkey, China, Slovakia, Armenia, USA, Romania, Iran, Armenia, Georgia, Morocco, South Africa and other countries participated in Young Scientists' Conference.

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

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

We are especially grateful to Prof. Viktor Khalack (Université de Moncton, Moncton, Canada) and also the following former students of the Astronomy and Space Physics of KNU whose contribution made it possible to provide personal grants for several participants from Ukraine: Kateryna Frantseva (Netherlands Institute for Space Research, Groningen, The Netherlands), Dr. Ievgen Vovk (Max-Planck Institut für Physik, Munich, Germany), Olena Torbaniuk (University Federico II in Naples, Italy). Also we would like to thank the deputy head of the Taras Shevchenko National University of Kyiv Students' Parliament Borys Topol for his support in the conference organization.

*Maksym Mohorian and
the Local Organizing Committee*

PROGRAMME

Monday, April, 22

09.00-13.00 - Registration
13.00-13.30 - Official opening

Section ‘Solar Physics & Heliosphere’

13.30-14.15 ??? (???) ??? (invited)

14.15-14.30 Andrii Prysiazhnyi (*Astronomical Observatory of Ivan Franko National University of Lviv, Lviv, Ukraine*) The features of photospheric jets of the quiet solar atmosphere (12+3)

14.30-14.45 Valeriia Liakh, M. Luna (*Instituto de Astrofísica de Canarias, Spain*) Large-amplitude oscillations in solar prominences in 2.5D models (12+3)

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

Tuesday, April, 23

Section ‘Extragalactic Astrophysics & Cosmology’

09.00-10.00 morning coffee

10.00-10.45 Giuseppe Longo (*Department of Physics "E. Pancini", University Federico II, Napoli, Italy*) Astrophysical big data: an overview of machine learning problems and methods (invited)

10.45-11.00 Olena Torbaniuk, M. Paolillo, G. Longo, M. D. Veneri (*Department of Physics "E. Pancini", University Federico II, Napoli, Italy*) Identification of candidate AGNs in multiband digital sky surveys (12+3)

11.00-11.15 Dmytro Orikhovskiy, V. A. Ponomarenko, A. O. Simon, V. V. Vasylenko (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Results of monitoring of AGN MRK 501 in optical range (12+3)

26th Young Scientists' Conference on Astronomy and Space Physics

- 11.15-11.30** Beata Zjawin, P. Ablewski, K. Beloy, S. Bilicki, M. Bober, R. Brown, R. Ciuryło, R. Fasano, H. Hachisu, T. Ido, J. Lodewyck, A. Ludlow, W. McGrew, P. Morzyński, D. Nicolodi, M. Schioppo, M. Sekido, R. Le Targat, P. Wcisło, P. Wolf, X. Zhang, M. Zawada (*Institute of Physics, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University, Toruń, Poland*) First Earth-scale quantum sensor network: dark matter searches with the use of optical atomic clocks (**12+3**)
- 11.30-11.35** Emine Gülmez (*Yeditepe University, Atasehir/Istanbul, Turkey*) XMM-Newton Observation of Galaxy Cluster Abell 262 (**poster**)
- 11.35-12.00** tea break
- Section 'High Energy Astrophysics'**
- 12.00-12.15** Volodymyr Savchenko (*Chemin d'Ecogia 16, Geneve, Switzerland*) Elusive short and energetic multi-messenger transients (**12+3**)
- 12.15-12.30** Artem Bohdan, M. Pohl, J. Niemiec (*Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany*) Production of non-thermal electrons at nonrelativistic quasi-perpendicular shocks of young supernova remnants (**12+3**)
- 12.30-12.45** Anton Dmytriiev, H. Sol, A. Zech (*Laboratory Universe and Theories, Paris Observatory, Paris, France*) A new code for modeling variable multi-wavelength emission during blazar flares (**12+3**)
- 12.45-13.00** Roman Gnatyk (*Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Magnetar SGR 1900+14 as a source of high energy and very high energy gamma-rays (**12+3**)
- 13.00-13.15** Olena Kompaniets, A. A. Vasylenko (*Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine*) Compton-thin absorber in type 2 Seyfert Markarian 417 observed by NuSTAR and Swift/BAT (**12+3**)
- 13.15-13.30** Vadym Voytsekhovsky, R. B. Gnatyk (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Search for Sources of Extremely High Energy Cosmic Rays in the Local Universe (**12+3**)
- 13.30-13.45** Mariana Patrii, O. Petruk, T. Kuzyo (*Ivan Franko National University of Lviv, Lviv, Ukraine*) Evolution of the structure of Tycho SNR as from observations in the X-ray range (**12+3**)
- 13.45-14.00** Paweł Szewczyk (*Warsaw University Astronomical Observatory, Warsaw, Poland*) Exploring solution space of differentially rotating neutron stars (**12+3**)

14.00-14.05 Anatolii Vasylenko (*Main astronomical observatory of NAS of Ukraine, Kyiv, Ukraine*) The obscured active nucleus of NGC 7172 as seen by NuSTAR (**poster**)

14.05-15.00 lunch

15.00-20.00 City tour (walking tour)

Wednesday, April, 24

Section ‘Solar System & Exoplanets’

09.00-10.00 morning coffee

10.00-10.45 ??? (???) ??? (invited)

10.45-11.00 Olena Shubina, N. Kiselev, V. Rozenbush, O. Ivanova, V. Afanasiev, V. Kleshchonok (*Main Astronomical Observatory of National Academy of Sciences of Ukraine, Kyiv, Ukraine*) Effect of contamination by gas emissions for comet polarization (**12+3**)

11.00-11.15 Oleksandra Lukina, A. R. Baransky (*Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Astrometry and photometry of transneptunian objects at Kyiv comet station (**12+3**)

11.15-11.30 Jakub Morawski, T. Trifonov (*Astronomical Observatory, University of Warsaw, Warsaw, Poland*) Ups Andromedae revisited. Dynamical characterization and a fourth outer Jovian planet in the system (**12+3**)

11.30-12.00 tea break

Section ‘Computer Modeling in Astronomy’

12.00-12.15 Illya Bilinsky, P. Berczik, A. Just, B. Shukirgaliyev, D. Ivanov (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Investigation of Galactic star clusters mass loss processes using the star by star large scale direct N-body simulations (**12+3**)

12.15-12.30 Yurii Pekarskyi, V. M. Reshetnyk (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Scattering of electromagnetic waves on complex dust aggregates (**12+3**)

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12.30-12.35 Aakash Narayan (*Department of Astronomy, Osmania University, Hyderabad, India*) GALEX SDSS catalog (GSWLC-1) study with machine learning and classification in Astrophysics (**poster**)

13.00-14.00 lunch

18.00-22.00 Organ hall / opera hall / etc.

Thursday, April, 25

Section 'Stellar Astrophysics and Interstellar Medium'

09.00-10.00 morning coffee

10.00-10.15 Vitalii Breus, I. L. Andronov, P. Dubovsky, K. Petrik, T. Hegedus (*Odessa National Maritime University, Odessa, Ukraine*) Change of the spin period and possible third body in the intermediate polar FO Aqr (**12+3**)

10.15-10.30 Sergii Pokhvala (*Main Astronomical Observatory of NAS of Ukraine, Kyiv, Ukraine*) Spectroscopic Short time-scale variability of O-B stars (**12+3**)

10.30-10.45 Jaime Andrés Rosales Guzmán, R. E. Mennickent, G. Djurasevic, I. Araya, M. Curé, M. Cabezas, F. González (*University of Concepción, Concepción, Chile*) A new sub-orbital period in DD Cma with partial evidence of accretion disk formation (**12+3**)

10.45-11.00 Maksym Mohorian, Ya. V. Pavlenko (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Proxima Centauri emission lines as activity indicators (**12+3**)

11.00-11.15 Bartosz Etmanski, M. R. Schmidt, R. Szczerba (*Nicolaus Copernicus Astronomical Centre of the Polish Academy of Sciences, Warsaw, Poland*) Ammonia in circumstellar environment around C-rich stars (**12+3**)

11.15-11.30 Miroslav Fedurco, Š. Parimucha (*Institute of physics, Faculty of Science, Pavol Jozef Šafárik University in Košice, Košice, Slovakia*) Double eclipsing binary system KIC 3832716 (**12+3**)

11.30-11.45 Miriam Kosik, K. Słowik (*Institute of Physics, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University, Toruń, Poland*) Controlling properties of light-matter interaction as a potential tool for astronomy (**12+3**)

- 11.45-12.00** Viktor Kudak, Š. Parimucha (*Institute of Physics, Faculty of Science, Pavol Jozef Šafárik University, Košice, Slovakia*) Influence of starspots on determination of 3rd body orbital parameters in eclipsing binary systems **(12+3)**
- 12.00-12.30** tea-break
- 12.30-12.45** Zofia Kaczmarek (*Warsaw University Astronomical Observatory, Warsaw, Poland*) Lensing by intermediate-mass black holes **(12+3)**
- 12.45-13.00** Mateusz Zieliński, Ł. Wyrzykowski, M. Gromadzki, P. Zieliński, K. Kruszyńska, K. Rybicki (*Warsaw University Astronomical Observatory, Warsaw, Poland*) Microlensed source spectral analysis **(12+3)**
- 13.00-13.15** Ihor Koshmak, B. Ya. Melekh (*Ivan Franko National University of Lviv, Lviv, Ukraine*) Photoionization modelling of the H II regions surrounding star-forming regions within metallicity range $Z=0.003-0.012$ **(12+3)**
- 13.15-13.30** Yevhen Vasylykivskyi, S. V. Stepkin, A. A. Konovalenko (*Institute of Radio Astronomy of the National Academy of Sciences of Ukraine, Kharkiv, Ukraine*) Detection of extremely high excited states of the interstellar Rydberg carbon atoms **(12+3)**
- 13.15-13.30** Oleh Buhajenko, B. Ya. Melekh (*Ivan Franko National University of Lviv, Lviv, Ukraine*) Detailed calculation of diffuse ionizing radiation transfer in nebular component of star-forming dwarf galaxies **(12+3)**
- 13.30-13.45** Myroslav Kasheba, B. Ya. Melekh (*Ivan Franko National University of Lviv, Lviv, Ukraine*) Redetermination of chemical abundances in planetary nebulae using recent atomic data **(12+3)**
- 13.45-14.00** Agnieszka Mirocha, A. Karska, L. E. Kristensen, M. Gładkowski, M. Żółtowski (*Jagiellonian University, Krakow, Poland*) Molecular emission around low-mass protostars in the Serpens Main with IRAM 30m **(12+3)**
- 14.00-14.15** Blanka Világos, B. Côté, M. Lugaro (*Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, Budapest, Hungary*) The isolation time of the Solar System **(12+3)**
- 14.15-14.20** Yuliia Kalinina, V. M. Reshetnyk (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Gaia Alerts in X-ray and radio ranges **(poster)**
- 14.20-14.25** Yana Markus, V. M. Reshetnyk, V. Godunova (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Photometric data processing of Gaia alerts **(poster)**

14.30-15.30 lunch

17.45-20.00 Excursion to Pinchuk Art Center

Friday, April, 26

Section 'Atmospheric studies and space geophysics'

09.00-10.00 morning coffee

10.00-10.45 Gennadi Milinevsky (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) ??? (invited)

10.45-11.00 Dmytro Vlasov, A. S. Parnowski (*Space Research Institute, Kyiv, Ukraine*) Modeling of Local Magnetic Field Prediction (12+3)

11.00-11.15 Yuliia Yukhymchuk, G. Milinevsky, V. Bovchaliuk (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Synergy of lidar and sun-photometer observations over Kyiv, Ukraine (12+3)

11.15-11.30 Oksana Ivaniha, A. R. Klekociuk, G. P. Milinevsky (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Polar tropopause seasonal behavior by the PACT data (12+3)

11.30-11.45 Denys Hladikov, V. Choliy (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Comparison of major aerosol pollutants over Europe and China area by GEOS-Chem model data (12+3)

11.45-12.00 Andrii Hulin, Yu. Rapoport, V. Grimalsky (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Algorithms and modeling of propagation of low-frequency electromagnetic wave in the earth-ionosphere waveguide (12+3)

12.00-12.15 Bohdan Petrenko, L. V. Kozak, E. Kronberg, E. Grigorenko, A. Lui (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Dispersion relation concept to turbulent medium of the geomagnetic tail (12+3)

12.15-12.30 Sergei Petrishchevskii, Yu. Rapoport, V. Grimalsky (*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Theoretical models of ionospheric perturbations and interaction in the system "Earth-atmosphere-ionosphere" (12+3)

Programme

12.30-12.45 Kateryna Reka, L. V. Kozak, B. Petrenko, A. T. Y. Lui, E. Kronberg
(*Taras Shevchenko National University of Kyiv, Kyiv, Ukraine*) Alteration
of pressures in the tail of the Earth's magnetosphere during the substorm
initiation **(12+3)**

12.45-13.30 Poster section + tea-break

13.30-14.00 Official closure

14.00-15.00 lunch

Saturday, April, 27

09.00-13.00 Museum of Folk Architecture and Life of Ukraine

INVITED LECTURES

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Astrophysical big data: an overview of machine learning problems and methods

Giuseppe Longo

Department of Physics "E. Pancini", University Federico II, Napoli, Italy

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Astrophysics has been among the few sciences to pioneer the big data revolution. Since more than two decades, a new generation of detectors and dedicated survey telescope is producing a huge data flow which cannot be processed and interpreted using traditional methods. This has caused not only a fast rise in the adoption of machine learning methods to perform most of the trivial tasks, such as pre-processing and objects extraction, but also the advent of a new generation of methods capable to extract in an automatic way the useful and often complex information hidden in the data. A few examples in the field of extragalactic astronomy will be outlined.

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Gennadi Milinevsky

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The tasks and progress in development of Ukrainian space project Aerosol-UA are discussed. The mission aims in providing information on the terrestrial atmospheric aerosol spatial distribution and microphysics to quantify the aerosol contribution to the climate change and planet energy budget modeling. The aerosol remote sensing concept of the project is based on precise orbital measurements of the intensity and polarization of sunlight scattered by the atmospheric aerosols and the surface.

SOLAR PHYSICS & HELIOSPHERE

The features of photospheric jets of the quiet solar atmosphere

Andrii Prysiazhnyi

*Astronomical Observatory of Ivan Franko National University of Lviv, Lviv,
Ukraine*

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3D hydrodynamic models of photospheric jets were constructed by solving the inverse radiative transfer problem for the spectral line FeI 557.608 nm. We used results of observations of a quiet region in the center of the solar disk (swedish SST/CRISP solar telescope). The models include thermodynamic parameters and a velocity field, both vertical and horizontal.

It has been revealed that photospheric jets arise at the edge of the descending fluxes of a magnetized plasma with a unipolar magnetic field and are localized at the site of collision of two horizontal flows. In photospheric jets, the stratification of excess pressure reaches a maximum in the layers of the middle photosphere and decreases towards the upper and lower layers. At the same time, the density inside the jets is significantly increased in the upper photospheric layers compared with the density of the environment, while in the lower layers it is slightly reduced.

Large-amplitude oscillations in solar prominences in 2.5D models

Valeriia Liakh, M. Luna

Instituto de Astrofísica de Canarias, Spain

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We performed 2.5D simulations of the large-amplitude oscillations (LAO) in solar prominences using MHD code Mancha 3.0. Sheared arcade as initial magnetic structure was used and flux rope was formed applying converging motions in direction to the polarity-inversion line (PIL) from the both sides. This process allowed to create twisted magnetic structure that contains dip needed to support prominence mass. In order to have model of real prominence, plasma with typically observed characteristics was added to the dipped magnetic structure. Flux rope was no longer in equilibrium so it was necessary to let the system evolve and relax. Since new equilibrium position was found we perturbed the prominence applying velocity 20 km s^{-1} in order to have LAO. We studied systems with different parameters of the prominence such as density contrast (light and heavy prominence), initial shear

angle, final twist number. Applying perturbation as a source to horizontal and vertical equations of motion we obtained oscillations of different polarisations with respect to the magnetic field (longitudinal and transverse). Simulations showed that periods of longitudinal oscillations are typically larger than periods of transverse oscillations. Also periods has tendency to increase with increasing of density contrast. It is believed that trigger of LAO is wave that comes from some energetic event (flares or subflares). Additionally we considered simulations of prominence oscillations excited with external source. In this case we studied how perturbation penetrates to the flux rope and how it is triggering oscillations in the prominence. And this numerical experiment showed that external perturbation excites mainly oscillations with vertical polarization.

EXTRAGALACTIC ASTROPHYSICS & COSMOLOGY

Identification of candidate AGNs in multiband digital sky surveys

Olena Torbaniuk¹, M. Paolillo¹, G. Longo¹, M. Delli Veneri²

¹*Department of Physics "E. Pancini", University Federico II, Napoli, Italy*

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An important problem in extragalactic astronomy concerns the influence of the presence of active nucleus (AGN) on the large-scale processes in the host galaxy and the correlation between the evolution of the host galaxy and the supermassive black hole (SMBH) in its centre. This connection between galaxies and SMBHs is suggested by the observed tight correlation between the evolution of star-formation rates (SFRs) and AGN activity. But the complexity of separating the radiation of the AGNs from that of the host galaxies over a wide range of redshift and in different wavebands remains one of the essential problems in this topic.

The identification of AGNs in large digital sky surveys is further complicated due to the radiation contamination by star-forming regions and other objects in the host galaxy. The solution of this issue requires the adoption of various selection criteria (and their combination) based on the properties of AGN emission in different wavebands, e.g. optically obscured AGNs can be identified only from their radiation in mid-infrared and X-ray bands.

We present the analysis and correlations of AGNs identification methods in optical, mid-IR and X-ray bands for about 600 thousands galaxies from the 8th Data Release of Sloan Digital Sky Survey (SDSS DR8) performed by MPA-JHU group (galSpec catalogue). Mid-IR and X-ray data for the SDSS objects were obtained from the All-sky Data Release Wide-field Infrared Survey Explorer (WISE) and the XMM-Newton Serendipitous Source Catalogue: 3XMM-DR8, respectively.

Results of monitoring of AGN MRK 501 in optical range

Dmytro Orikhovskiy, V. A. Ponomarenko, A. O. Simon, V. V. Vasylenko

Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

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The results of systematical monitoring of selected object from the CTA optical follow up list, started in 2018 are presented. The observations are carried out with the AZT-8 (D = 70 cm, F = 2.8 m) telescope of the observation station Lisnyky of Taras Shevchenko National University of Kyiv. This telescope was included in the list of supporting instruments in the CTA consortium. The AZT-8 equipped with the PL4710-1-BB-E2V CCD and broadband Bessel UBVRI filters.

Light curves for object Mrk 501 were plotted. Variability of color indexes with time were investigated. We determined the variability amplitude for Mrk 501 for Intraday Variations (IDV) and Short (STV) where it was possible. The results and methods were analysed.

First Earth-scale quantum sensor network: dark matter searches with the use of optical atomic clocks

Beata Zjawin¹, P. Ablewski¹, K. Beloy², S. Bilicki¹, M. Bober¹, R. Brown², R. Ciuryło¹, R. Fasano², H. Hachisu³, T. Ido³, J. Lodewyck⁴, A. Ludlow², W. McGrew², P. Morzyński¹, D. Nicolodi², M. Schioppo², M. Sekido³, R. Le Targat⁴, P. Wcisło¹, P. Wolf⁴, X. Zhang², M. Zawada¹

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Observations at astronomical scales provide a strong evidence for the existence of dark matter. It is responsible for the structures that we see in the Universe, however we do not know what it consists of. We can only observe the gravitational interactions of our matter with dark matter, for example the impact that it have on stars and galaxies. Examining dark matter structure requires fine models that explain its composition in both macro and micro scales. Searches for dark matter in form of topological defects or oscillating massive scalar fields must be executed in the best laboratories in the world that enable examining the fundamentals of physics. We established the first Earth-scale quantum sensor network based on optical atomic clocks. It is aimed at dark matter detection. We provide a new bounds on dark matter-standard model coupling for the cases of both topological-defect dark matter and oscillating massive scalar fields. We use the archival data to constrain existing dark matter models. With the use of Yb and Sr optical atomic

clocks placed at three continents to improve the previous results by two orders of magnitude.

XMM-Newton Observation of Galaxy Cluster Abell 262

Emine Gülmez

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In this study, we present the analysis results from deep (~ 129 ks) XMM-Newton archived observation with ObsID 0504780101 of Abell 262 galaxy cluster. As being a cool core nearby ($z=0.01742$) cluster, we examine temperature and metal abundance distributions of intra-cluster medium (ICM) and address ICM's thermodynamic properties.

HIGH-ENERGY ASTROPHYSICS

Elusive short and energetic multi-messenger transients

Volodymyr Savchenko

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Recent years were marked by accelerated development of time domain astronomy, owing to the evolution of observational techniques in wide-field rapid optical and radio surveys, as well as development of the computing resources and methods necessary to promptly interpret overwhelmingly rich observational data. In addition, gravitational waves and neutrino observatories finally reached a degree of maturity that has enabled breakthrough multi-messenger observations of previously undetected fundamental physical processes in space.

The properties or even the very nature of many of the new classes of transient sources remain obscure: they are typically associated with peculiar supernovae, mergers of compact objects, or tidal disruption events. In order to decipher the complex physical processes at play in these exceptional systems, it is vital to combine exhaustive and diverse observations. Among the most interesting, and yet the most challenging is the observation of the hard X-ray and gamma-ray emission: it often reveals a distinct emission component that points to the most dense and energetic regions at the heart of the source.

In this talk, I will discuss how recent contributions of INTEGRAL observatory to pioneering multi-messenger observations help to reveal mechanisms at the core of the merging compact objects, collapsing massive stars, and tidal disruption events. I will review some of the implications of these observations for production of heavy elements, cosmology, and fundamental physics.

Finally, I will review how the recent discoveries in the domain of multi-messenger transients were made possible by a global effort to achieve a new degree of automation and interoperability. In particular, I will present the Online Data Analysis (ODA) platform, developed at Common Data Center Infrastructure of UniGE facilities to facilitate reduction and analytics of astronomical data, and review some of the ongoing projects and future plans for consolidating and designing scientific data analysis workflows in the distributed environment.

Production of non-thermal electrons at nonrelativistic quasi-perpendicular shocks of young supernova remnants

Artem Bohdan

Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany

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The injection problem is a key and still unresolved issue of diffusive shock acceleration theory. Electron injection mechanisms at high Mach-number nonrelativistic quasi-perpendicular shocks are under consideration here for parameters that are applicable to young SNR shocks. Using high-resolution large-scale two-dimensional fully kinetic particle-in-cell (PIC) simulations we explore the production of high-energy electrons in the shock transition. Tracing individual particles we in detail analyze the physics of the formation of non-thermal electron population. Ion reflection off the shock leads to the formation of magnetic filaments in the shock ramp, resulting from Weibel-type instabilities, and electrostatic Buneman modes in the shock foot. Electrons are accelerated via shock surfing acceleration (SSA) in the Buneman-instability region and undergo further scattering in the Weibel-instability region via a second-order Fermi-like and magnetic reconnection processes. The combination of these processes leads to the formation of a non-thermal electron population, but their individual impact strongly depends on the Alfvénic Mach number and reduced ion-to-electron mass ratio. We discuss the resulting electron spectra and the relevance of our results to the physics of systems with real ion-to-electron mass ratio and fully three-dimensional systems.

A new code for modeling variable multi-wavelength emission during blazar flares

Anton Dmytriiev, H. Sol, A. Zech

Laboratory Universe and Theories, Paris Observatory, Meudon, France

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Blazars are Active Galactic Nuclei (AGN) with jets directed very nearly towards the observer. These objects are highly variable, featuring flares in Very High Energy (VHE) gamma-ray band, during which the energy flux can increase by a factor of ~ 10 within time scales ranging from minutes to days. There are several competing theoretical models of the flaring phenomenon, which take into account different physical processes. Two main families of models have been proposed, namely leptonic and hadronic ones. The origin and nature of flaring activity of a specific source can be understood by finding a complete model that describes the observational data, in particular, temporal and spectral characteristics of the variable emission.

We developed a new leptonic code for time dependent modeling of multi-wavelength emission during blazar flares. We consider that the emission is produced in a plasma blob, embedded in a tangled magnetic field, and relativistically moving along the jet. We assume that low energy electrons are either instantaneously or continuously injected into the blob and undergo stochastic (Fermi II) or shock (Fermi I) acceleration. The distribution of the electrons radiates according to a one-zone synchrotron self-Compton (SSC) scenario, supplemented by synchrotron self

absorption and gamma-gamma absorption processes. The electrons cool through radiative and adiabatic losses, and can also escape the emitting region. We numerically solve the kinetic equation, which describes the evolution of the electron spectrum, taking into account the processes mentioned above, and compute at each time step the associated broad-band SED of the emission from the blob, as well as the light curves in various spectral ranges.

We investigate the influence of the model parameters on the SEDs and on the light curve profiles in different energy bands, and apply our code to archival flares of Mrk 421.

Magnetar SGR 1900+14 as a source of high energy and very high energy gamma-rays

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Magnetars are neutron stars with an extremely high magnetic fields $\sim 10^{14} - 10^{15}$ G and appear as two classes: transient soft gamma repeaters (SGRs) and anomalous X-ray pulsars (AXPs). In three of them giant flares were observed (SGR 0526+66 on 1979 March 5; SGR 1900+14 on 1998 August 27; SGR 1806+20 on 2004 December 27), with the release of energy of order of $10^{44} - 10^{46}$ erg during a short time interval ~ 0.1 s. In our work we made simulation of the observed high energy ($E > 100$ MeV, Fermi LAT) and very high energy ($E > 100$ GeV, H.E.S.S.) gamma-ray emission flux from the vicinity of the magnetar SGR 1900+14. We show that the total observed gamma-ray emission can be contributed by magnetar-connected Supernova remnant and giant flare on the magnetar.

Compton-thin absorber in type 2 Seyfert Markarian 417 observed by NuSTAR and Swift/BAT

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We present results of X-ray spectral analysis of the Seyfert type 2 galaxy Mrk 417 observed by the NuSTAR satellite in 2017 for ~ 21 ks as well as the Swift/BAT satellite. We use the spectral data obtained from two FPM detectors in 3-50 keV energy band together with the spectrum from Swift-BAT 105 month catalogue in

the 14-195 keV band. This broad-band spectrum shows a good fit with a baseline model composed of an absorbed cutoff power-law component and reflected emission form accompanied by a narrow fluorescent iron- K_α line from cold matter. A semi-infinite neutral slab was used as the reflecting medium. The continuum of spectrum is steep ($\Gamma \sim 1.6$) and is absorbed by Compton-thin ($N_H \sim 30 \times 10^{23} \text{ cm}^{-2}$) neutral gas. There are Fe K_α energy of 6.3 keV and moderate EW $\sim 116 \text{ \AA}$ are consistent with transmission through this absorber. Therefore, we also decided explored more physically motivated approach which can take into account both absorption and reflection in a self-consistent way. To this aim, we applied the MYTorus model in coupled mode. This model includes three separate components transmitted flux, reflected flux and fluorescence lines. Using this assumption we derived that inclination angle and the equatorial column density of the absorber are 86 deg and $34 \times 10^{23} \text{ cm}^{-2}$ respectively. The intrinsic luminosities are estimated to be $3.2 \times 10^{43} \text{ erg/s}$ in 2-10 keV and $4.4 \times 10^{43} \text{ erg/s}$ in 10-40 keV energy band.

Search for Sources of Extremely High Energy Cosmic Rays in the Local Universe

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The origin and nature of ultra high energy cosmic rays (UHECRs, $E > 10^{18} \text{ eV}$) are still unknown. Protons and nuclei among UHECRs, on their way from the source to the observer, lose their energy due to interaction with extragalactic background light, and heavy nuclei suffer as well from photodisintegrations. Deflection of UHECR trajectories in Galactic and extragalactic magnetic fields further complicates the search for sources of UHECRs. The magnetic field deflection decreases with increase the energy of UHECRs, therefore we search for sources of extremely high energy cosmic rays (EHECRs, $E > 10^{20} \text{ eV}$). To this end we recover a sky position of sources of EHECRs, detected by TA and AUGER detectors, taking into account EHECR deflections in Galactic and extragalactic magnetic field and energy losses of EHECRs. A set of potential EHECR sources among AGN and star-burst galaxies is determined and analysed according to the recent models of EHECR acceleration.

**Evolution of the structure of Tycho SNR
as from observations in the X-ray range**

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We are interested in analyzing of remnant of Tycho supernova that had exploded in 1572. The data of observations are taken from Chandra Space Telescope, which works in the X-ray range and allows us to observe the Universe in the electromagnetic band that is invisible to the human eye. The main goal of our research is to study the time evolution of the remnant in the period from 2003 to 2015 years. We have produced images of the remnant for different years in different energy ranges. We have also extracted spectra for thermal and non-thermal emission from small regions around the shock which were fitted using respective spectral models.

Exploring solution space of differentially rotating neutron stars

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Properties of matter inside neutron stars are yet to be fully discovered. Multiple models for equation of state are considered nowadays, but even with simple models the stationary solutions of neutron stars' structure create a complex solution space. Exploring this space can be crucial to fully understanding the nature of these objects and help with both further theoretical work as well as in understanding the observational data.

In this talk I will present some of the results from LORENE code showing properties of differentially rotating neutron stars in the simple case of polytropic equation of state. I will focus on finding the stability criterion similar to already existing for uniformly rotating neutron stars.

The obscured active nucleus of NGC 7172 as seen by NuSTAR

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We present the hard X-ray spectral analysis of NGC 7172, the nearby ($z=0.0087$) Seyfert 2 galaxy. This analysis is based on the spectral data from a 32 ks NuSTAR observation in 3-64 keV energy band. We find, that NGC7172 showed a constant Compton-thin obscuration $N_H \approx 8 \cdot 10^{22} \text{ cm}^{-2}$, i.e. is similar to that observed by XMM-Newton, Suzaku, ASCA and BeppoSAX over past 30 years.

We revealed the presence of a primary power-law continuum with $\Gamma \sim 1.8$, a moderate reflection component with $\langle R \rangle \sim 0.44$ and a narrow Fe K_α line with $67 \pm 14 \text{ eV}$. The application of the numerical torus models, such as BNTorus and MYTorus, confirmed the Compton-thin type of the Seyfert nucleus and allowed us to obtain an estimation of the torus opening angle $\theta_t \sim 59^\circ$ and inclination $\theta_i \sim 61^\circ$.

The measured intrinsic 2-10 keV ($L_{intr}(2-10 \text{ keV}) = (1.14-1.23) \cdot 10^{43} \text{ erg/s}$) and 10-40 keV ($L_{intr}(10-40 \text{ keV}) = (1.56-1.62) \cdot 10^{43} \text{ erg/s}$) luminosity of NGC 7172 indicate the brightening of source in X-rays as compare with previous data for ~ 18 years. Using the data of previous observations, we demonstrate also the long-term variability of $L_{intr}(2-10 \text{ keV})$ almost by order and EW Fe K_α by factor ~ 4 on a timescale of ~ 12 years. And this corresponds to the distance of $d \sim 3.7 \text{ pc}$ between central source and reprocessing medium. Such changes of intrinsic luminosity without changes in N_H value indicate the variability of a central source. In the whole, our results are in agreement with the scenario, where the observed Fe K_α line is generated in a distant gas-dust torus.

SOLAR SYSTEM & EXOPLANETS

Effect of contamination by gas emissions for comet polarization

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Remote observations of sunlight scattered by solid particles provide information on the particle properties for a large variety of comets. In order to find out dust characteristics one can use polarization observations. For this purpose polarization in a cometary continuum should be considered. But it is difficult to allocate the pure continuum that is free from contamination by the emission bands. Nevertheless, narrow-band continuum filters or broader-band filters in less contaminated spectral domains (red or near infrared) are currently used to avoid or reduce the contributions from gaseous emission. Additionally, there are also other factors influenced on deviation of linear polarization degree from theoretical calculations.

In this work we present the analysis of possible reasons, that cause deviations in polarization using the data from the second release of Database of comet polarimetry. The investigation of the gas contamination effect on polarization in cometary continuum of selected comets is also presented.

Astrometry and photometry of transneptunian objects at Kyiv comet station

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We present the results of astrometric and photometric observations of transneptunian objects obtained at Kyiv comet station (Code MPC 585) of the Astronomical Observatory of Taras Shevchenko National University of Kyiv in 2017-2019. Orbital elements and physical properties of objects (color index, geometric albedo, and absolute magnitude) were measured. The accuracy of all the observations and calculations was analyzed. The comparison with data in Asteroids with Satellites Database Johnston's Archive showed consistency, thereby it was defined that Kyiv comet station is appropriate for TNO researches. Astrometric data were published in Minor Planet Supplement and Minor Planet Center database.

**Ups Andromedae revisited. Dynamical characterization
and a fourth outer Jovian planet in the system**

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Ups Andromedae is the first multi-exoplanet system discovered around a main sequence star. In Butler et al. 1999 it was described as a three planet system, with 4.6, 241 and 1267 orbital periods respectively. Since then the dynamics the system has been studied extensively. However, in Curiel et al. 2011 evidence was shown for a fourth planet, which due to a very long period of about 4000 days could not have been found before.

Almost a decade later, we use new observations with the HARPS spectroscope to better constrain the parameters of the outer planet's orbit. We attempt a dynamical fit for orbits' inclinations and hint that the system is likely much closer to edge-on than suggested by previous dynamical studies, which did not include the fourth planet. During the talk a new fitting radial velocity fitting tool will be advertised, which we are developing and intend to release soon.

COMPUTER MODELING IN ASTRONOMY

Investigation of Galactic star clusters mass loss processes using the star by star large scale direct N-body simulations

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Galactic open star clusters plays sizable role in the process of feeding the Galactic disc with different stellar star populations. In comparison with the globular clusters populations the open star clusters are much younger, less massive and mainly located inside the Galactic disk. We investigate the complex dynamical evolution of the star cluster population in Milky Way disk using the large scale direct N-body simulations which include also the stellar evolution routines. We present the results of computer modeling and investigating of models of young star clusters on Galactic disc with the direct star-by-star simulations. Kroupa Initial Mass Function was considered with the different star formation efficiencies (15%, 17%, 20%, 25%). The models was integrated using the direct MPI parallel N-body phi-GRAPE/GPU code. We investigated a time dependence of such a parameters: virial ratio, tidal radius (Jacobi radius), half mass radius and tidal (bounded) mass. We also try to fit the number distribution of stars with a King profile for a different stages of evolution.

Scattering of electromagnetic waves on complex dust aggregates

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Electromagnetic radiation is the main source of information for astronomy. Thus, it is important to understand the physics of light spreading, refraction and

scattering. In this work, we were using the DDscat C++ software to plot electromagnetic waves, scattered by complex particles, formally called "aggregates". We have built the scattered electromagnetic fields depending on different types of a target: first type – the spheres "stick" if the trajectory brings them into contact with the cluster; second type – the spheres "migrate" after the first contact until they make a contact with the second sphere from the cluster; and the third type – after second contact the spheres make the second migration to contact the second sphere from the cluster. Having the scattering results brings us to understanding of the light spreading in any dust clouds, such as in planet atmospheres, solar system, interstellar, and even intergalactic medium – every medium with dust in it.

**[TO REMOVE] GALEX SDSS catalog (GSWLC-1) study
with machine learning and classification in Astrophysics**

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The study of FUV and NUV under Galex SDSS Cataloging.

STELLAR ASTROPHYSICS & INTERSTELLAR MEDIUM

Change of the spin period and possible third body in the intermediate polar FO Aqr

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We continue our photometric monitoring of the intermediate polar FO Aqr since 2008. CCD observations were obtained mainly using 1-meter VNT and smaller telescopes at the Vihorlat Astronomical Observatory in Kolonica and 60-cm Zeiss-Cassegrain at the Observatory and Planetarium in Hlohovec, Slovak Republic. Some runs used in this work were obtained using 50-cm telescope of Baja Astronomical Observatory, Hungary. The CCD frames were processed using C-Munipack and WinFits. The final time series were obtained using MCV.

The previous published values of the spin period were 0.^d01451905 (Patterson et al., 1998) and 0.^d01451718 (Williams, 2003). The period variations of FO Aqr are complicated. According to historic data, from 1981 to 1987 the white dwarf showed a spin-down, then it changed to a spin-up. Andronov et al. (2005) confirmed a continuation of decrease of the spin period reported by Williams (2003). Breus et al. (2012) reported the highest peak at the periodogram corresponds to the photometric period of 0.^d014312(5) – a daily alias of the white dwarf spin period published before.

O-C diagram for the data obtained in 2008-2018 shows a linear trend from year to year, which argues for the correction of the used value of the period. We may conclude that the period is 0.^d014517857(2) with an initial epoch of 2457197.07455(16). This linear trend does not agree with historic data, and one hypothesis is about abrupt change of the spin period between 2001 and 2004.

We repeated the O-C analysis using new ephemeris and found sinusoidal-like variations with the period about 15.8 years. This may be interpreted as a presence of a third body, orbiting the inner binary system. This research will be continued.

Spectroscopic Short time-scale variability of O-B stars

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We report the detection of high-frequency variations in the hydrogen Balmer lines and helium lines in the hot O-B stars. Spectral observations were carried out with slitless spectrograph ($R \sim 100,200$) and spectrograph UAGS installed on the 60 cm Carl Zeiss telescope in the Andrushivka Observatory and also with spectrograph Alpy 600 with small telescope. Spectra were obtained with a time resolution in the sub-second and second range. It has been found that the hot stars shows rapid variations in the hydrogen lines and He lines as well as variations in the atmospheric oxygen lines. The Hydrogen lines show the bimodal structure of a spectral line. The Oxygen line (the Earth's atmosphere) doesn't show it. This proves the reality of the bimodal structure of a spectral Balmer lines. This bimodal structure in line profiles can be interpreted as a non-radial pulsations. The intensity variations in the hydrogen lines varies from 0.2% to 0.5% , and that of the oxygen lines is approximately 2%.

**A new sub-orbital period in DD CMa
with partial evidence of accretion disk formation**

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We present a detailed photometric and spectroscopic analysis of the Double Periodic Variable DD CMa whose main characteristic is that presents an extremely-short orbital period of $P_o = 2.0084 \pm 0.0001$ d. In addition we detected a sub-orbital period $P_s = 0.335 \pm 0.001$ d using ASAS light curve which could be related to pulsations from the gainer star. The equivalent width of H α profile shown a cyclical

variation of $0.5P_o$ the orbital period with a mean 1.4229 ± 4.805 , possibly related to escaping material caused by the direct impact of the stream on the accretion disk. Through a spectroscopically analysis we determined the fundamental parameters and features for a slightly evolved donor star of $M_2 = 1.81 \pm 0.06 M_\odot$ and temperature $T_2 = 9670 \pm 200$ K. Whereas the hot star has a mass $M_1 = 6.60 \pm 0.07 M_\odot$ and $T_1 = 21000 \pm 1000$ K surrounded by and small optical and geometrically thick accretion disk of extension $R_d = 5.4 \pm 0.1 R_\odot$ and temperature $T_d = 8410 \pm 200$ K. The system is seen under inclination $84^\circ.1 \pm 0^\circ.1$ to a distance $d = 1553.427 \pm 506.499$ pc.

Proxima Centauri emission lines as activity indicators

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Proxima Centauri is a late-type M dwarf which shows flaring activity. In this research the most significant emission lines' behavior was analyzed using the archived HARPS spectra (H_α , HeI, NaI & CaII) during a flare accident which took place on MJD2456417. The point of research was to provide the theoretical understanding of the intensity changes and the correlation of this change in different lines.

Ammonia in circumstellar environment around C-rich stars

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The HIFI instrument on board of the Herschel Space Observatory (HSO) has been very successful in detecting molecular lines from circumstellar envelopes around evolved stars, like massive red supergiants, Asymptotic Giant Branch (AGB) and post-AGB stars, as well as planetary nebulae. Among others, ammonia has been found in circumstellar envelopes of C-rich AGB stars in amounts that significantly exceeded theoretical predictions for C-rich stars. Few models have been proposed to resolve this problem: formation of ammonia behind the shock front, photochemical processes in the inner part of the envelope partly transparent to UV background radiation due to the clumpy structure of the gas, and formation of ammonia on dust grains. Careful analysis of observations may help to put constraints on one or another mechanism of formation of ammonia. Here, we present results of the non-LTE radiative transfer modeling of ammonia transitions including a crucial process of radiative pumping via $v_2 = 1$ vibrational band ($10\ \mu m$) for C-rich stars for sample of C rich stars observed with the HIFI instrument. Most available observations of our sample objects include only ground-based ammonia transition $NH-3\ J = 1_0 - 0_0$ at 572.5 GHz. Therefore, to determine abundance of ammonia we estimate a photodissociation radius of NH_3 using chemical model of the envelope consistent with dust grain properties concluded from the spectral energy distribution.

Double eclipsing binary system KIC 3832716

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We analyzed the light curve of the object KIC 3832716 observed during Kepler K1 mission. We showed that this previously known eclipsing binary is in fact quadruple system, in double eclipsing binary configuration on a long period orbit with the mass ratio of eclipsing binaries 0.7 ± 0.3 . The system consists of eclipsing binary A with the orbital period of $P_A \sim 1.1419d$. Eclipsing binary A contains larger but less luminous secondary component in the post main sequence stage of its evolution consistent with an "Algol paradox" which can explain parameters of

the components by mass transfer from secondary component after leaving the main sequence. Inspection of the light curve and eclipse time variations of the eclipsing binary A also indicates the presence of spots on the surface of secondary component with 57 d period of activity probably induced by longitudinal motion of the spots. The second eclipsing binary B with orbital period $P_B \sim 2.1703$ d contains very dim secondary component with luminosity below $0.09 L_\odot$.

**Controlling properties of light-matter interaction
as a potential tool for astronomy**

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One of the main tasks in astronomy is the the interpretation of electromagnetic radiation reaching Earth from extraterrestrial sources. Studying light-matter interactions on quantum level may contribute to better understanding of the numerous properties and the possible origin of observed light. Quantum mechanical measures like the temporal statistics of incoming photons in a light beam allow to determine better how the light was created and what processes it underwent on its way to the observer. Better knowledge of processes occurring in quantum emitters may help to understand emission processes in natural light sources. Controlling the processes in atoms can also lead to improvement of the speed and efficiency of light detectors as well as allow to produce more efficient single-photon sources.

Interaction of a quantum emitter with the surrounding photonic bath in its ground state yields a correction to the emitter's transition energy, referred to as Lamb shift, and gives rise to the process of spontaneous emission. Spontaneous emission can be controlled when the photonic environment is altered, e.g. with plasmonic or dielectric nanoparticles.

In this contribution, we provide analytical expressions for spontaneous emission rate of an emitter that is located in a tailored photonic environment taking into account interference terms in the light-matter interaction up to electric quadrupole. To provide examples, we apply the formalism to simple geometries like a planar interface between two different media or a nanoparticle, and identify scenarios where a step beyond the electric dipole approximation is necessary for accurate description of emitters' dynamics.

**Influence of starspots on determination
of 3rd body orbital parameters in eclipsing binary systems**

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Influence of starspots on O-C diagram variation is presented. To build O-C diagrams times of minima was defined from light curves of detached and contact binaries produced in PHOEBE software. Simulation of 3rd body presence in light curves of this eclipsing binary system is made according to Irwin (1952). Determination of orbital parameters of a 3rd body from the O-C diagram performed by MCMC algorithm described in Gajdoš & Parimucha (2019).

Reviewed different sizes of starspots on eclipsing binary systems components, location and migration of starspot was taking into account. Determination of starspot(s) influence on 3rd body orbital parameters made by comparison of these parameters determined in ideal condition case, without influence of other factors on O-C diagram, and O-C diagram distorted by spot(s). Presented errors, produced by starspot(s).

Lensing by intermediate-mass black holes

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Intermediate-mass black holes (IMBHs) are one of the yet unsolved problems of astronomy. These objects - with masses of $10^2 - 10^5 M_\odot$ - are the missing link between the well-known populations of stellar-mass black holes and supermassive black holes in the centres of galaxies. If found and studied on a large scale, they could provide useful information about the evolution of galaxies and supermassive black holes. However, very few IMBHs have been found so far and there is little evidence about them.

A possible method for finding and studying IMBHs is looking for specific gravitational lensing events. It could shed light on the problem of presence of IMBHs in the Milky Way. We expect that, with increasing precision of the following data releases, such events could be found in the Gaia mission data.

Microlensed source spectral analysis

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Lightcurve modelling has been playing a dominant role in microlensing observations. However, spectroscopic follow-up can provide us with plenty of insight into these transients. Using just pairs of SEDs and photometric points, we should be able to algebraically decompose observed spectra into both source's and lens' light components. By further analysis, including the spectroscopic parallax method, important parameters of the objects involved can be obtained independently from the lightcurve modelling. This procedure allows for model verification, degeneracy breaking with additional constraints, and possibly gives us new interpretations or characterisations of the events. We follow the demonstration by Santerne et al. 2016 and try to apply this method to analyse a few microlensing transients from Gaia Alerts.

**Photoionization modelling of the H II regions surrounding
star-forming regions within metallicity range $Z=0.003-0.012$**

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We represent the new approach to model the ionization structure of the high-metallicity H II regions. The method is based on multicomponent photoionization modelling (MPHM) of these objects that takes into account their complicate structure due to superwind from the central star-forming region. The complex structure of H II region has been divided into internal and external components.

Internal components correspond to the region of free expansion of superwind and the cavity of superwind correspondingly, while the external ones – to a thick layer of gas, compressed by a superwind shock, and hydrodynamically undisturbed outer part of H II region, where the most of observed strong emission lines are formed. The components of the model were calculated in the assumption of spherical symmetry. The gas photoionization was caused by ionizing quanta of both direct and diffuse ionizing radiation. Fluxes of this radiation were calculated during simulation using radiative transfer equations which take into account all important processes in the H II region that are causing this transfer. The diffuse ionizing radiation was

calculated in the outward only approach. In the region of free expansion of the supwind the chemical abundances were determined using evolutionary population synthesis models of star-formation region. The distribution of the electron temperature and density in the external components was obtained in such modelling as solution of the photoionization energy balance equation. It was adopted the stop criterion for evolutionary modelling corresponding to the condition of equilibrium of pressure on the boundary between third and fourth components. The evolutionary grid of multicomponent high-metallicity models of H II regions was calculated. It was shown that internal structure of H II region under some conditions can cause the formation of a lack of quanta in the spectrum of ionizing radiation.

Detection of extremely high excited states of the interstellar Rydberg carbon atoms

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Low-frequency radio spectroscopy is one of the most effective methods of cold interstellar medium (ISM) diagnostics. Radio recombination lines (RRLs) at extremely low frequencies have proven to be one of its most sensitive probes. These lines were detected for the first time at UTR-2 radio telescope by A. Konovalenko and L. Sodin in 1978. In this report the detection of decameter carbon RRLs corresponding to transitions when the principal quantum numbers are changing from $\Delta n = 1$ (α -transitions) to $\Delta n = 5$ (ε -transitions) will be discussed. Observations have been carried out using UTR-2 radio telescope and multi-channel digital correlometer near frequency 30 MHz. Toward supernova remnant Cassiopeia A (Cas A) direction RRLs corresponding $n = 599 \dots 606$, $n = 754 \dots 764$, $n = 862 \dots 874$, $n = 949 \dots 961$ and $n = 1022 \dots 1035$ have been detected. Carbon RRL 1035ε is the spectral line from the mostly excited atom observed in space. Obtained line widths are in good agreement with theoretical calculations. Also the precise method of determining line characteristics at high n where the wide Lorentzian wings of neighboring RRLs overlapped will be described. Detection of carbon atoms with such high excited levels is important astrophysical result. Detailed studies of these interstellar spectral features can yield more deep knowledge about many important processes in the ISM.

**Detailed calculation of diffuse ionizing radiation transfer
in nebular component of star-forming dwarf galaxies**

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The photoionization analysis of chemo-dynamical dwarf galaxies simulations (see Melekh et al., MNRAS, 2015) allows us to study the ionization structure and the spectral properties of the nebular component in these objects. For such analysis galaxy volume was divided into 20 sectors per quater in axial symethry assumption. Spatial distributions of density and chemical compositions as well as temperature in superwind region and their evolution obtained as result of chemo-dynamical simulations (Recchi & Hensler, A&A, 2013) were used as input data for multicomponent photoionization modelling (MPhM) of the nebular component in these objects. The photoionization modelling was performed for each sector separately, because Outward Only approximation for calculation of diffuse ionizing radiation transfer was adopted.

However, as it was shown in our recent papers (see Buhaienko & Melekh, JPS, 2017), the Outward Only approximation for calculation of diffuse ionizing radiation transfer can causes the significant deviations from results obtained using detailed method. Especially such deviations can be important for objects with strong inhomogenities in density distribution as well as for the large spatially distributed low-density nebular objects. Nebular components surrounding active star-forming regions are both large and inhomogenious. Therefore, it was necessary to test the faithfulness of usage of Outward Only approximation in MPhM of these objects.

In present work we represent resulting ionization structure and spectral properties of simulating dwarf galaxies with star-forming perocesses obtained using MPhM with impelemented method for detailed calculation of diffuse ionizing radiation transfer (see Buhaienko & Melekh, AASP, 2018). These results were compared with ones obtained previously by us (see Melekh et al., MNRAS, 2015) using Outward Only approximation. Clear conclusions about the possibility of using of Outward Only approximation during photoionization modelling of rarefied nebular environment in star-forming dwarf galaxies were done.

**Redetermination of chemical abundances in planetary nebulae
using recent atomic data**

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The grid of photoionization models of planetary nebulae (PNe) envelopes was calculated using code Cloudy 17.01 along the evolutionary tracks of their nuclei for two types of dust grains (carbonates and silicates) and various masses of progenitor stars. Two types of the chemical abundances averaged over ones of PNe in Large Magellanic Clouds (LMC) and Milky Way (MW) correspondingly were adopted. The radial density distribution of matter in models was defined using Golovaty-Malkov (1992) semi-empirical law.

Resulting ionic abundances as well as assumed in models chemical compositions were used to determine the new ionization-correction factors (ICFs) for PNe. These ICFs are used for redetermination of the chemical abundances in real PNe of MW and LMC galaxies. New abundances were compared with previous ones, obtained using old version of photoionization code (Cloudy 08.00). The causes of differences between these results were analyzed.

Molecular emission around low-mass protostars in the Serpens Main with IRAM 30m

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A new-born protostar forms in dense cores deep inside molecular cloud. Due to high extinction in the optical range, observations at long-wavelengths are needed. In particular, submillimeter spectra include rotational lines of key molecules which are useful probes of physics and chemistry around low-mass protostars. Here, we analyse molecular emission from the Serpens Main star forming regions using IRAM 30 m single dish telescope. HCN, CN, and CS emission is modelled using radiative transfer code RADEX to determine the gas physical conditions and molecular abundances. The presence of UV radiation in these regions is identified and compared to models of dense envelopes irradiated by UV photons. Thus, we gain new understandings of chemical and physical processes around low-mass protostars.

The isolation time of the Solar System

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Remapping what happened shortly before the formation of the Solar System (SS) is a challenging task. However, we can uncover the possible reasons for its early composition. The abundance of some radioactive nuclei at the formation of the SS are well-measured based on primeval meteoritic samples. Using a galactic chemical evolution code, we compare the predicted abundance of several radioactive nuclei to their measured early SS values. Most of them were less abundant than calculated - the apparent deficit can be explained by the physical isolation of the matter of the SS from the galactic interstellar medium 20-100 million years before the Sun formed. The results from different nuclei show that the value of the isolation time correlates with their parent nucleosynthesis process, which means that different events may stopped contributing to the composition of the SS earlier than others. However, ²⁶Al (with half-life 0.7 Myr) is more abundant in the early SS than what the model predicts, which is evidence for a nearby event soon before the formation of SS. These results may be suitable to have an insight to the prehistoric times of the SS as well as to test the validity of the current models for the production of radioactive nuclei in stars.

Gaia Alerts in X-ray and radio ranges

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Gaia Alerts is an all-sky photometric transient survey which is based on measurements by the Gaia satellite. The repeated scans are needed to determine precise stellar positions. In addition, they are useful to search for variations in brightness of sources. In this paper, we present the object-by-object comparison of Gaia alerts with Chandra X-ray catalog, as well as WISH, GLEAMEGCAT and VLSSR radio catalogs. Results of this comparison could help to clarify the nature of the objects.

Photometric data processing of Gaia alerts

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Gaia Space Telescope during Sky Scanning to accomplish its goals finds many objects that unpredictably change their brightness - transient events or alerts. They require compulsory additional observations from the ground observatories to determine the nature of such shine changes that can be made during episodic observations by Gaia. In this work we have analyzed light curves of such alerts: Gaia18azl, Gaia18avw and Gaia18agr. We have obtained estimates of photometric parameters of these objects, calculated color indices B - V and V - R, and based on this, the temperature of objects in the approximation of an absolutely black body was estimated.

ATMOSPHERIC STUDIES & SPACE GEOPHYSICS

Modeling of Local Magnetic Field Prediction

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The regression modeling method was developed on the basis of the mathematical statistics and the regression analysis. This method provides forecasting the local geomagnetic activity with 3 hours lead time. We calculated models of each component of the local magnetic field.

Forecast models of local magnetic fields are calculated for stations located on the territory of France, the USA, and Ukraine. For the solution of the practical problems of space weather, the results obtained have a significantly higher relevance than planetary indices. A preliminary model gives linear correlation coefficient 90-91%, prediction efficiency 80-85% and skill score 17-33% for the sample from 2009 to 2017.

Synergy of lidar and sunphotometer observations over Kyiv, Ukraine

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The report presents the results of the aerosol particles optical and microphysical properties and aerosol distribution analysis in the atmosphere over Kyiv. The data have been obtained by lidar and photometer observations. The lidar CIMEL370 observations have been provided during July-September 2015 in connection with the sunphotometer measurements at Kyiv AERONET station, which is located on the roof of the Main Astronomical Observatory building of the National Academy of Sciences of Ukraine in Kyiv. The sunphotometer observations at Kyiv station have been provided since 2008. Comparison of aerosol characteristics with corresponding

aerosol optical thickness (AOT) values obtained by the AERONET algorithm was done and the influence of air mass transfer was studied.

The coefficient of extinction altitude variations were analyzed using lidar measurements campaign at Kyiv AERONET station. During the observation period, the extinction coefficient values vary within the range of 0.05 – 0.08 at altitudes up to 4 km. At the start of September, higher values the extinction coefficient were observed which associated with aerosol smog over Kyiv. Observations of the AERONET network were also used to compare with the lidar measurements and to construct a map of the mean values of AOT for the territory of Ukraine using the platform GIOVANNI for scientific observational statistics. The obtained results show that the usual AOT value over Kyiv varies from 0.2 to 0.3. In the case of emergencies event (such as peat burning, forest fires) AOT values may have severe deviations. A cluster analysis of the air mass transfer over the territory of Ukraine has been provided for the lidar observations period. In the second part of July, the north-west transfer of air mass was dominant. At the beginning of August, the most of the air trajectories came from the east. The northern air trajectories direction was dominant, which had contribution to the transfer of aerosol fires particles from northern regions of Ukraine to Kyiv in the first part of September.

Polar tropopause seasonal behavior by the PACT data

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The tropopause is a region of vital interest in understanding climate processes and global change because of conditions within and in the vicinity of this region is highly sensitive to various dynamical, radiative and chemical processes. The polar tropopause is the most sensitive to the global climate changes and their influence on the troposphere-stratosphere interaction. Therefore, the tropopause study is important for the understanding of the global atmospheric conditions and climate. The PACT database includes the high resolution ozone/temperature data from radiosondes (balloons) above selected polar sites. Each balloon ascent provides the profile of ozone concentration, pressure, temperature and humidity (PTU) as a function of altitude, and the spatial location of the balloon derived from ground-based radar or differential Global Positioning System (GPS) measurements. The vertical resolution is typically 10 meters for raw measurements. The behavior of the

monthly averaged thermal (LRT) and ozone(OT) tropopause and their correlation with the total ozone column and differences between temperature at the 500 and 100 mb pressure level have been analyzed in the report. The tropopause heights seasonal behavior, both ozone and thermal are very close but the LRT altitude maximum is higher and shifted in 1-2 months relative to OT heights. The minimum of the both tropopauses are behind the maximum for about 4 months. The OT height minimum is more clearly seen, even better then maximum. Analysis of the correlations shows that monthly averaged OT height anticorrelate with monthly averaged total ozone and LRT behavior strongly correlate with temperature differences at the 500 and 100 mb.

**Comparison of major aerosol pollutants
over Europe and China area by GEOS-Chem model data**

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Aerosol distribution in the atmosphere over East Europe has been analysed with use of the chemical-transport model GEOS-Chem data. Data spatial resolution is 2.5 degrees by latitude and 5 degrees by longitude. The area of 40°–60N, 20W–140E was considered during the simulation. The aerosol particles spatial distribution and seasonality was simulated. The possible areas of aerosol sources of anthropogenic origin as plausible reason of atmosphere aerosol pollution over Europe and China were estimated.

Except salt, all the mentioned aerosol types showed a clear similarity in their distributions. There are two main maxima of concentrations, in Europe: South Poland and around Moscow, but some individual features for separate types are available. The model has exhibited higher concentrations in Belarus in comparison with Ukraine in the majority of cases. Of course, reliability of the conclusions must be checked by means of the observational data processing. Lesser increase of the aerosol concentration was indicated in Romania. At this, Turkish values seem to be unexpectedly low.

With its dense population, fast economic growth and huge rate of urbanization, China is experiencing extreme aerosole air pollution problems. This is particularly the case in Central-Eastern China, where the two major cities of Beijing and Tianjin are located. GEOS-Chem model show that the atmospheric aerosol load in these regions is considerably higher than in the urbanized regions of Europe.

Algorithms and modeling of propagation of low-frequency electromagnetic wave in the earth-ionosphere waveguide

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We present new complex method for calculating electromagnetic beams (IMEB) propagation in multi-layered waveguide with gyrotropy, inhomogeneities and thin cover layer above the waveguide. Most important feature of the proposed IMEB method is that the effective impedance is adequately determine the impact of the cover layer on the EMW propagation in the waveguide, in spite of large thickness of such a cover. This impedance approach is possible to use for wide frequency range from VLF to optics for layered gyrotropic/anisotropic active media of artificial or natural origin (for example waveguide "Earth-Ionosphere" (WGEI) for radio waves radiated by ground transmitter or lightning). The model allows adequate simulation of VLF waves/beams both propagating in and leakage from the waveguide Earth-Ionosphere. The numerical results on excitation and beam propagation in the Earth-Ionosphere waveguide.

Dispersion relation concept to turbulent medium of the geomagnetic tail

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In our study we set out to establish validity of the dispersion relation concept to the magnetic field turbulent fluctuations in the Earth's magnetotail. For this purpose, fast method of direct determination of the dispersion relation from multi-point measurements was used. This technique of wave surveying allows identifying a single dominant wave mode for scalar or vector data, not limited to a certain number of sensors. We applied this multi-spacecraft analysis to each component of the magnetic field in the regions of manifestation of the magnetic substorm expansion phase. This process is accompanied by occurrence of such plasma discontinuities as dipolarization fronts (DFs) in the geomagnetic tail. Moreover, in our work with help of minimum variance and timing analyses we found characteristics of DFs' propagation.

The work was conducted in the frame of joint scientific research projects of scientists of Taras Shevchenko National University of Kyiv and the National Academy of Sciences of Ukraine for 2019-2020, the grant Az. 90 312 from the Volkswagen Foundation ("VWStiftung") and International Institution of Space Research (ISSI-BJ).

**Theoretical models of ionospheric perturbations
and interaction in the system "Earth-atmosphere-ionosphere"**

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We present in details the algorithm of the electrostatic – quasi-stationary-electromagnetic/MHD approximations and equivalent external sources (EQUEMES method) to develop the quasi-stationary/electromagnetic algorithms of seismo-ionospheric coupling.

The penetration of the electromagnetic field was simulated by solving equations for the horizontal electric field components E_x , E_y of the second order with respect to the vertical coordinate z . This system of two second-order equations is derived from the system of Maxwell equations. The penetration of rather strong horizontal electric field to the ionospheric E and F layers have been modeled.

A possibility of the effective initiation of electron concentration perturbations in the unstable near-equatorial plasma in the F layer of the ionosphere by the packet of atmospheric gravity waves (AGW) radiated by the near-ground source is illustrated. A good correspondence of the results obtained on the basis of this model to the data of satellite observations is shown.

**Alteration of pressures in the tail of the Earth's magnetosphere
during the substorm initiation**

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To date, there are two main scenarios of substorm development that are characterized by localization and mechanics – in the first approach (current disruption "CD" model) substorm develops at distances of 6-15 radii of the Earth due to small-scale breaks, in the other one (the Near-Earth Neutral Line "NENL" model) – initiation in the middle of the tail at distances of 15-30 radii of the Earth is assumed at the expense of large-scale processes that involve the reconnection of magnetic lines. In this case, the nature of the development will depend on both the processes in the solar wind and the internal state of the magnetosphere directly at the beginning of the phase of expansion. The contrast between the two theories of substorm development is due to the fact that physical mechanisms for them are different kinetic instabilities. For NENL, it is mainly a discontinuous instability that breaks the current layer into "magnetic fibers". For CD it is cross-tail current instability, which is determined by the ratio of the drift and thermal velocity of the ions. This instability has a lower threshold than the tearing instability, therefore its development can create the necessary conditions for the beginning of magnetic reconnection. Both scenarios have common patterns: magnetic reconnection and the inevitable propagation of dipolarization (DP) tailward. Due to this, they equally successfully provide a proper interpretation of substorm manifestations, such as accelerating particles, dipolarization, formation of a current wedge and injection. In addition, as part of the CD model, the moment of substorm precedes the moment of reconnection, and within the framework of the NENL – vice versa.

In the work we conducted analysis of dynamic, scalar and magnetic pressures during the initiation of the substorm. Four events during 2014-2015 years were reviewed. Contribution of each pressures in general picture of processes in the Earth's magnetotail was estimated.

The work was conducted in the frame of common research project of KNU and NANU scientists for 2019-2020 years the grant Az. 90 312 from the Volkswagen Foundation ("VW-Stiftung") and International Institution of Space Research (ISSI-BJ).

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