June 16 – 18, 2023, Guesthouse on Bezovec, Nová Lehota

About the conference

Traditional meetings of astronomers at Bezovec wrote their 55th chapter in 2023. The main focus of the conference, which was held from 16 to 18 June 2023, was the presentation of the scientific research activities of young astronomers, mainly university students.

Conferences on the achievements of stellar astronomy are among the prominent events organized annually by the Slovak Astronomical Society and the Observatory and Planetarium of M. R. Štefánik in Hlohovec. These meetings have traditionally enabled the exchange of experience between professional astronomers and those interested in variable star observations as well as other areas of astrophysics from students, young people actively working in astronomical clubs, and also the staff of observatories and planetariums from all over Slovakia.

In 2020, we expanded the focus of the conference and gave space to the staff of Slovak observatories and planetariums to present the results of their activities in various areas of astronomical research. The conference's central theme in 2021 was the presentation of research activities of 40 young astronomers, mainly university students. The subject of the 2022 conference was the presentation of new scientific as well as older, lesser-known findings in the history of astronomy.

In 2023 we followed up the successful Bezovec 2021 as well as the Meetings of Astronomy and Astrophysics Students, which took place in June 2022 in Ostrava during the Meeting of constituents and collective members of the Czech Astronomical Society. The traditional Bezovec conference was held on June 16 – 18, 2023, in the Guesthouse on Bezovec. The Czech Astronomical Society, the Faculty of Science of the P. J. Šafárik University in Košice, and the Faculty of Mathematics, Physics, and Informatics of Comenius University in Bratislava also participated in its preparation and organization.

The main theme of the conference was the presentation of the scientific research activities of young astronomers in various areas of astronomical research. The conference was attended by 41 participants, the vast majority of whom were university students at master's and doctoral level. The Comenius University in Bratislava and Charles University in Prague had a significant representation. However, among the participants there were also students from P. J. Šafárik University in Košice, Masaryk University in Brno, Technical University in Košice, Mendel University in Brno, Astronomical Institute of the Czech Academy of Sciences in Ondřejov, Institute of Experimental Physics of the Slovak Academy of Sciences in Košice, and Astronomical Institute of the Slovak Academy of Sciences in Tatranská Lomnica.

The programme of the conference was not only about contributions (34 in total). In addition to presentations of research results achieved not only during the preparation of the theses, the participants could also discuss about the possibilities of mutual cooperation in the field of astronomical research. Such discussions could also take place during a hiking trip to Tematín Castle or the social evening of the Slovak Astronomical Society.

The organizers are pleased that the participants evaluated the conference as a successful and are already looking forward to the next edition of the traditional conference in Bezovec.

assoc. prof. RNDr. Rudolf Gális, PhD.
chair of conference organizing committee

Participants

Samuel Amrich, *Charles University in Prague*
Daniela Bartková, *Comenius University in Bratislava*
Kamil Bicz, *Astronomical Institute of the University of Wrocław*
Atre Bodnárová, *M. R. Štefánik Observatory and Planetarium in Hlohovec*
Peter Butka, *Technical University of Košice*
Patrik Čechvala, *Comenius University in Bratislava*
Marianna Dafčíková, *Masaryk University in Brno*
Pavol A. Dubovský, *Vihorlat Observatory in Humenné*
Pavol Gajdoš, *P. J. Šafárik University in Košice*
Rudolf Gális, *P. J. Šafárik University in Košice*
Ľubomír Hambálek, *Astronomical Institute of Slovak Academy of Sciences in Tatranská Lomnica*
Žofia Chrobáková, *Comenius University in Bratislava*
Filip Janák, *Comenius University in Bratislava*
Marek Jurčík, *Comenius University in Bratislava*
Lenka Kališková, *Technical University of Košice*
Matúš Kamenec, *Slovak Union of Astronomers, Humenné*
Róbert Kožurko, *M. R. Štefánik Observatory and Planetarium in Hlohovec*
Viera Krešňáková, *Technical University of Košice*
Hana Kučáková, *Silesian University in Opava*; *Charles University in Prague*
Vitalii Kuksenko, *Comenius University in Bratislava*
Radovan Lascsák, *Charles University in Prague*
Šimon Mackovjak, *Institute of Experimental Physics of Slovak Academy of Sciences in Košice*
Pavol Mártonfi, *P. J. Šafárik University in Košice*
Roman Nagy, *Comenius University in Bratislava*
Tomáš Ondro, *Mendel University in Brno*
Dmytro Orikhovskyi, *Comenius University in Bratislava*
Karol Petrík, *M. R. Štefánik Observatory and Planetarium in Hlohovec*
Nikolaos Samaras, *Charles University in Prague*
Myank Singhal, *Charles University in Prague*
Marko Šegon, *Astronomical Institute of Academy of Sciences of Czech Republic in Ondřejov*
Jiří Šilha, *Comenius University in Bratislava*
Ladislav Šmelcer, *Observatory in Valašské Meziříčí*
Michal Šturc, *Comenius University in Bratislava*
Stanislav Šúst, *Slovak Astronomical Society, Hurbanovo*
Michal Švanda, *Charles University in Prague; Astronomical Institute, Czech Academy of Sciences*
Jana Švrčková, *Charles University in Prague*
Vasiliki Tsioutra, *not indicated*
Pavol Valko, *Slovak university of Technology in Bratislava*
Anhelina Voitko, *Astronomical Institute of Slovak Academy of Sciences in Tatranská Lomnica*
Matej Zigo, *Comenius University in Bratislava*

Conference programme

Friday, June 16, 2023

16:00 – *Registration of participants*

18:00 – Opening ceremony

Scientific session 1

Michal Švanda - *Highlights of the solar research in the last decade: Convergence or divergence?*

Anhelina Voitko, Oleksandra Ivanova - *Variations of cometary dust color beyond 3 au*

19:00 – *Dinner*

20:00 – Scientific session 2

Marko Šegon, Jiří Borovička - *Analysis of Digital Meteor Spectra*

Vitalii Kuksenko - *A new method of distinguishing among cosmogonic models of the Solar System*

Dmytro Orikhovskyi - *Precession of the orbital planes and rotational axes in transiting exoplanet*

21:00 – *Welcome cocktail*

Saturday, June 17, 2023, morning sessions

08:00 – *Breakfast*

09:00 – *Scientific session 3*

Roman Nagy, Žofia Chrobáková - *Galaxies in the Universe - From History to the Modern Age*

Filip Janák - *Structure of the Galaxy*

Myank Singhal - *On the coherent evolution of stellar structures in the Galactic Centre*

Marek Jurčík - *Stellar streams and galactic mergers*

10:20 – *Coffee break*

10:40 – *Scientific session* 4

Ľubomír Hambálek, Theodor Pribulla, Martin Vaňko, Ján Budaj, Emil Kundra - *Spectroscopy of selected T Tauri stars*

Ladislav Šmelcer, Marek Wolf, Hana Kučáková - *A photometric study of NSVS 7453183: a probable quadruple system with long-term surface activity*

Pavol Gajdoš, Štefan Parimucha - *Spotted eclipsing binary KIC 7023917 with δ-Scuti pulsations*

11:40 – *Coffee break*

12:00 – *Scientific session* 5

Pavol A. Dubovský, Karol Petrík, Vitaliy Breus - *Nova Herculi 2021 as an intermediate polar*

Pavol Mártonfi, Rudolf Gális, Jaroslav Merc - *Long-term evolution of colour indices of the symbiotic system AX Persei*

Jana Švrčková - *Dynamical stability of triple star HD 152246*

13:00 – *Conference photo*

13:05 – *Lunch*

14:00 – *Conference trip (Bezovec Hill or Tematín Castle)*

16:00 – *Scientific session* 6

Kamil Bicz, Robert Falewicz, Małgorzata Pietras, Paweł Preś - *Starspot and flare activity – differences and similarities between stars with different inner structure*

Kateřina Pivoňková, Olga V. Maryeva, Sergio Simón-Díaz - *Ups...! We did it again... New observational evidence for HVA events*

Jiří Šilha, Matej Zigo, Peter Jevčák, Danica Žilková, Daniela Bartková, Tomáš Hrobár, Daniel Kyselica - *Space debris research at Comenius University*

Matej Zigo, Jiří Šilha, Tomáš Hrobár - *Space weathering and aging effects observed on geostationary satellites*

17:20 – *Coffee break*

17:40 – Scientific session 7

Marianna Dafčíková - *Space weather effects at LEO as experienced by GRBAlpha*

Daniela Bartková, Jiří Šilha, Juraj Tóth - *Analysis of CZ-3B R/B re-entry event observed by all-sky camera system AMOS*

Radovan Lascsák - *Simulation of space debris removal by aerodynamic drag*

Patrik Čechvala, Jozef Masarik, Róbert Breier - *Exposure of extraterrestrial material to cosmic-ray particles*

19:00 – *Dinner*

20:00 – *Opportunities*

Šimon Mackovjak - *Opportunities for young astronomers at the Institute of Experimental Physics SAS*

Pavol Valko - *Satellites, spaceflight and universe, the amphitheatre for education*

General discussion

21:00 – *Slovak Astronomical Society Social Evening*

Sunday, June 18, 2023, morning sessions

08:00 – *Breakfast*

09:00 – *Scientific session* 8

Peter Butka, Šimon Mackovjak, Viera Krešňáková, Lenka Kališková - *Automatic segmentation of different solar atmosphere structures by deep learning*

Šimon Mackovjak, Viera Krešňáková, Peter Butka, Matej Varga, **Samuel Amrich**, Adrián Kundrát, Silvia Kostárová - *The Autonomous Service for Prediction of Ionospheric Scintillations (ASPIS) - Data analysis and preprocessing*

Viera Krešňáková, Šimon Mackovjak, Peter Butka, Matej Varga, Samuel Amrich, Adrian Kundrát, Silvia Kostarová - *The Autonomous Service for Prediction of Ionospheric Scintillations (ASPIS) - Developed Machine Learning models*

Lenka Kališková, Peter Butka, Viera Krešňáková, Šimon Mackovjak, Juraj Tóth, Pavol Zigo - *Applying YOLO for the detection of specific data within the field of astronomy*

10:20 – *Coffee break*

10:40 – Scientific session 9

Tomáš Ondro, Rudolf Gális - *The thermal history of the intergalactic medium at $3.9 \leq z \leq 4.3$* (poster presentation)

Tomáš Ondro, Rudolf Gális - *TECO – Temperature evolution code*

Nikolaos Samaras, Moritz Haslbauer, Pavel Kroupa - *Comparison of TNG Illustris simulations with Local Volume observations*

Michal Šturc - *Testing MOND in the Solar neighbourhood*

Pavol Valko - *Gravitomagnetism vs. Dark Matter, in conjunction with GAIA & Euclid data*

12:00 – *Closing ceremony*

12:30 – Lunch

Book of abstract

Michal Švanda - *Highlights of the solar research in the last decade: Convergence or divergence?*

The Sun is our closest star, and as such, it is the target of intensive research. Nowadays, it is being observed 24/7 across many bands of the electromagnetic spectrum. High-quality observations are accompanied by state-of-the-art data analysis and interpretation, which are also incorporated into numerical simulations of various processes occurring on the Sun. The question is: With all this effort, have we truly improved our knowledge of the physics of the Sun?

Voitko Anhelina, Ivanova Oleksandra - *Variations of cometary dust color beyond 3 au*

Comets are small bodies of the Solar system that possess activity as they get closer to the Sun. These objects have interesting nature. Understanding their physics could shed light on the formation of the Solar system. Most of the data concerning comets were obtained through studies of close and bright objects. But it is natural to assume that distant comets can differ from these objects: they were much less exposed to the Sun's radiation, have different activity mechanisms, and may have a different evolution. Our study is aimed to study the dust of comets at heliocentric distances larger than 3 au. Dust coma is a representation of nucleus material and can describe some of its properties. We mainly consider the photometric colour of the cometary dust environment, which is a ratio of fluxes measured at two different filters (wavelengths). This characteristic is dependent on dust particle size distribution and chemical composition. Consequently, we are looking for dust colour variations as they can represent changes in dust particle microphysical properties. As a main source of data, we used the archive of the Skalnaté Pleso observatory. We have structured it and selected monitoring observations of 8 comets for future work. For 4 of these comets, we found colour variations that occurred over a few days. We will use the obtained data for further modelling of dust properties. Moreover, we have analysed observations of Comet 29P/Schwassmann-Wachmann 1 during its two outbursts in 2018 and 2020. The earlier outburst is already described, and the results were published. For the second one, we will also perform a similar analysis soon.

Marko Šegon, Jiří Borovička - *Analysis of Digital Meteor Spectra*

Meteor spectroscopy has been a prominent field of research in the Czech Republic since 1960. For many years, a single station with an analogue camera system was used for observations. In 2015, a transition to multi-station digital photographic observations was made. Although of lower resolution, digital spectra offered a wider spectral range and were less affected by weather conditions, enabling the collection of a significantly larger amount of data. Currently, spectral cameras are working at eleven stations, including one in Germany and two in Slovakia. The use of multiple stations allowed for data comparison and a clearer sense of their reliability. Faced with the challenge of developing an accurate physical model for lower quality observations, a revised methodology was implemented through a newly-developed Python code. This talk will provide an overview of the various aspects of data calibration and modelling, including wavelength calibration, spectral sensitivity correction, and intensity correction based on the spectrum's position in the field of view.

Vitalii Kuksenko - ***A new method of distinguishing among cosmogonic models of the Solar System***

Cosmogonic models of the Solar System are usually based on hydrodynamic numerical simulations. These models aim to describe the complex evolution and observed structure of our planetary system. They can be divided into two groups – classical and dynamical. Each of them proposes unique evolutionary scenarios. One of the recent examples of dynamical models is the Grand Tack model. The main idea of the model is the assumption of planetary migrations. The competing model is the pebble-accretion model which does not involve migrations. There is still no consensus on which of the theories is the correct one. That is why we need a new method to distinguish between competing models. Here we will present a new approach of diagnostics of cosmogonic models by using the data from meteor observations. First, we will present the results of our bachelor's thesis on the research on the Grand Tack model and compare it with other cosmogonic models. Then we will look at the objects, the origin of which is hard to explain using non-migrational theories. These objects include rocky material that originated in the Oort cloud. Finally, we will make an introduction to the main goal of our future work – the investigation of the potential of using fireballs as a marker of the correctness of cosmogonic models.

Dmytro Orikhovskyi - ***Precession of the orbital planes and rotational axes in transiting exoplanet***

Orbital planes of numerous close-in exoplanets are not always perpendicular to the host star spin axis. This means that the current orbital plane of the exoplanet was probably altered after the system was formed. Projected spin-orbit misalignment can be measured in transiting exoplanets using so called Rossiter-McLaughlin effect affecting radial velocity of the host star. For fast-rotating host stars, where the radial velocities cannot be often measured with a sufficient precision, the planet signature can be found in the mean line profiles. Analysis of the profiles during the transit enables us to determine the projected spin axis-orbital plane misalignment. If the inclination angle of stellar spin axis is known from a high-precision photometry, the true misalignment can be determined. Some objects (e.g., Kepler-13Ab) were found to show precession of the exoplanet orbit caused by the tides due to the rotationally deformed parent star. These cause changes of the transit duration (TDV) due to the shift of the transit cord across the stellar surface. Exoplanet orbit precession is always connected with precession of the parent's star rotational axis due to the conservation of the total angular momentum. Its analysis brings us information on the internal structure of the star. The primary goal of the work is to predict precession rates for existing close exoplanetary systems and to synthesise long-term evolution of the mean line profiles, transit time duration and transit light curves. Another goal is to search for objects showing TDV combining ground-based and satellite photometry (Corot, Kepler, and TESS).

Roman Nagy, Žofia Chrobáková - ***Galaxies in the Universe - From History to the Modern Age***

This presentation provides an overview of galactic astrophysics, tracing its evolution from historical breakthroughs to modern discoveries based on Gaia observations. It highlights the influential "The Great Debate" of 1920 and its impact on our understanding of galaxies. The ensuing progress in technology and observational tools has paved the way for remarkable advancements in the field. One of the groundbreaking contributions comes from the Gaia mission, launched in 2013 by the European Space Agency. Gaia's precise measurements of stellar positions, distances, and motions have revolutionized our knowledge of the Milky Way and beyond. These measurements have unravelled the densely populated central region of our galaxy, shedding light on its structure, dynamics, and the complex interplay of stars and other celestial objects. Moreover, Gaia has extended our understanding to the Galactic outskirts, revealing mystery of their structure and evolution.

Filip Janák - *Structure of the Galaxy*

Although our Galaxy is the most studied among all galaxies in the universe, it is still not explored enough. Galore tempting questions considering structural features, origin, evolution, or dynamical mechanisms of our Galaxy are not sufficiently answered yet. Since the June 2022, the third Gaia data release (DR3) has been publicly accessible. Utilizing this valuable data, we focused our work on the Galactic disc's flare structure. The Galactic flare represents increase of the disc's scale height with radial distance. This structure can be examined in many ways. We started our analysis through the stellar density of the Galactic disc, although this method is rather challenging since we don't know the stellar density in distant regions. Thanks to the Gaia DR3, which has provided us with radial velocities for more than 33 million sources, we are able to investigate flare more precisely using the velocity dispersion.

Myank Singhal - *On the coherent evolution of stellar structures in the Galactic Centre*

Previous works have shown that nearby Keplerian stellar orbits can undergo a coupled secular evolution in a combined axially and spherically symmetric perturbative potential. This coupled evolution causes initially formed coherent stellar structures to survive for a relatively long time, even with gradual changes in their global properties. A prime example is the observed system in the Galactic Centre consists of the young stellar disc, gaseous torus, and the embedded spherical cluster. In this work, we extend the original analysis closer to the SMBH, where the orbits of the S- stars are supposed to be perturbed by the young stellar disc and post-Newtonian corrections to the gravity of the central SMBH.

Marek Jurčík - *Stellar streams and galactic mergers*

Gaia mission, as a state-of-the-art all-sky survey, provides stellar positions and kinematics with unprecedented precision. Crossmatching the data with spectroscopic observations has revealed specific structures in the Galaxy. Stellar streams (associations of stars grouped into circular filaments) have been extensively studied in the last decade (e.g., Bonaca 2021). The origin of these Galactic features is associated with disruption of a stellar cluster or with a galactic merger. Thus, studying stellar streams plays a key role in our process of understanding the history of the Milky Way galaxy and the physical processes governing its dynamics. This thesis will review the publications covering the stellar stream topic. An appropriate method of identifying stellar streams in Gaia kinematical data will be suggested and applied on the observations (especially Gaia EDR3/DR3). The results will be compared to the literature.

Ľubomír Hambálek, Theodor Pribulla, Martin Vaňko, Ján Budaj, Emil Kundra - *Spectroscopy of selected T Tauri stars*

We present results from long-term spectroscopic monitoring of 21 T-Tauri stars located in the Taurus-Auriga star-forming region. Medium and high-dispersion échelle spectroscopy was obtained at the Stará Lesná, Skalnaté Pleso (both Slovakia), Tautenburg (Germany), and Asiago (Italy) observatories between 2015 – 2018. Additional spectra from Stará Lesná were obtained in 2022. The broadening function technique was used to determine the radial and projected rotational velocities and to study the objects' multiplicity. The analysis was also focused on determining atmospheric parameters such as gravity log g, effective temperature T_{eff}, and metallicity *[Fe/H]*. We have investigated the effect of possible reddening on individual targets and constructed. The nature of the objects was assessed by measuring the equivalent width of Hα and Li I lines. Using pre-main-sequence evolutionary models, we discuss the age, masses, and radii of our targets.

Ladislav Šmelcer, Marek Wolf, Hana Kučáková - *A photometric study of NSVS 7453183: a probable quadruple system with long-term surface activity*

The VRC light curves were regularly measured for the eclipsing binary NSVS 7453183 as a part of our long-term observational project for studying of low-mass eclipsing binaries with a short orbital period and surface activity. The Tess light curve solution in Phoebe results to the detached configuration, where the temperature of primary component was adopted to T_1 = 4300 K according to the SED approximation. It gives us T_2 = 4080 ± 100 K for the secondary component. The spectral type of the primary component was estimated to be K6 and the photometric mass ratio was derived q = 0.86. We confirm presence of the third body in this system, a stellar companion with a minimal mass 0.33 $M_{\odot}$ orbiting the eclipsing pair with a short period about 425 days, and propose the next, fourth body with a longer orbiting period of about 12 years, probably a brown dwarf with the minimal mass of 50 M_{Jup}. The hierarchical structure ((1+1)+1)+1 of this quadruple system is assumed. Characteristics and temporal variations of the dark region on the surface of the primary component were estimated. The average migration speed of about 10°/month was found during years 2020-2022.

Pavol Gajdoš, Štefan Parimucha - *Spotted eclipsing binary KIC 7023917 with δ-Scuti pulsations*

Eclipsing binary KIC 7023917 is one of nearly three thousand other binaries in the well-known Kepler Eclipsing Binary Catalogue. However, it has some uncommon features. We focused on this system because we detected fast anti-correlated changes on the O-C diagram which could suggest the presence of apsidal motion. Though, these changes are very fast for apsidal motion and the orbit of this binary is circular. Detailed analysis of the Kepler and TESS light curves reveals deformation of the light curve by short-periodic pulsations and the O'Connell effect caused by stellar spot(s). Here, we present our initial study of this system and a possible explanation of the observed O-C diagram.

Pavol A. Dubovský, Karol Petrík, Vitaliy Breus - *Nova Herculi 2021 as an intermediate polar*

We were experiencing an increased rate of nova eruption on the northern hemisphere in recent years. One of them is V1674 Her = Nova Herculi 2021. The progenitor of V1674 Her is an intermediate polar with known white dwarf spin period before the nova eruption. We have measured the spin period in 2 season and already started the monitoring in the 3rd season. In this work, we present analysis of the spin period evolution. The period change is extremely fast. The mean value in 2022 was 88 mili-seconds shorter than in 2021. The typical value of the period change in "normal" intermediate polars is around 1-2 mili-seconds per year. For this reason, it is very difficult to correctly count the cycles. However, we made an attempt to construct the O-C diagram of spin maxima. The result suggests that the spin acceleration is now stable, and we can expect its slow decline in next decades.

Pavol Mártonfi, Rudolf Gális, Jaroslav Merc - *Long-term evolution of colour indices of the symbiotic system AX Persei*

Symbiotic stars are long-period interacting binaries, in which mass is transferred from cool component (red giant) to hot one (white dwarf). This is responsible for the outbursts - manifestation of their activity - that relate to significant photometric and spectroscopic changes. In our previous research of symbiotic system AX Persei, the light and radial velocity curves of this variable as well as the behaviour of strong emission lines in its spectra were analysed. We present the investigation of the binary's *U-B*, *B-V*, *V-Rc*, *V-Ic* and *Rc-Ic* colour indices in this contribution. To compute them we used the magnitudes in the *U*, *B*, *V*, *Rc* and *Ic* photometric filters, which were adopted from available scientific sources (papers, telegrams, circulars) and the AAVSO database. Detailed analysis of the long-term evolution of colour indices was performed. The timing and magnitudes of all their extrema were determined and different behaviour across investigated quiescence and active phases was observed. The research was supplemented by correlation and period analysis of the curves of indices.

Jana Švrčková - *Dynamical stability of triple star HD 152246*

Hierarchical triple stars consist of two stars orbiting each other on a close orbit and a third, more distant star. This is the only observed dynamically stable configuration of triple systems. The third star needs to be far enough from the close binary, otherwise the stars start moving chaotically which eventually results in ejecting one of the components out of the system. This condition is described by several criteria of dynamical stability. HD 152246 is a hierarchical triple star which seemingly does not fulfil any of the stability criteria. Using a recently measured set of spectra, I tried to obtain more precise and accurate orbital elements of this system. My goal was to find out whether the system really does not fulfil the stability criteria and what dynamical effects occur in this triple system.

Kamil Bicz, Robert Falewicz, Małgorzata Pietras, Paweł Preś - *Starspot and flare activity – differences and similarities between stars with different inner structure*

Low-mass main-sequence stars exhibit intense flaring and spot activity, likely due to convective layers and magnetic dynamos. TESS has revolutionized the study of stellar activity. In our analysis, we investigated the connection between flares and star spots on various stars with different internal structures. We selected highly active M and K main sequence stars, with up to 4.5 flares/day, from the TESS data. Using BASSMAN software, we modelled starspots and analysed light curves with WARPFINDER to identify and estimate the parameters of flares. We examined the temporal evolution of starspot modulation, its influence on flare light curves, and the impact of flares on planetary habitability. Our starspots models were tested to unveil insights into the overall stellar magnetic field and its correlation with flares. Notably, we discovered large, long-duration flares in white light, whose brightness is modulated by rapid stellar rotation. We observed that the occurrence frequency of flares didn't always align with rotation phases, except in some cases. Our findings showed starspots at latitudes exceeding 70 degrees, surpassing typical solar spot latitudes due to rotations. Most of the analysed stars exhibited activity levels insufficient to deplete ozone or support abiogenesis on hypothetical orbiting planets.

Kateřina Pivoňková, Olga V. Maryeva, Sergio Simón-Díaz - *Ups...! We did it again... New observational evidence for HVA events*

Late B- and early A-type supergiants are interesting, evolved stars known for photometric and spectroscopic variability. Particularly interesting is a group of pulsating stars named after Deneb as α Cyg variables. These variables are known for a long time to show variability in both brightness and radial velocities. Despite the Deneb-type variables undergoing continuous observations, the underlying processes responsible for such changes are not yet well understood. In addition, there is a 'subgroup' of α Cyg variables containing eight stars (as we know for now) showing extraordinary events known as High-Velocity Absorption (HVA). As the name reveals, it is about a deep absorption unusually Doppler-shifted to blue or red concerning the laboratory wavelength. Peculiar events are observed in Balmer lines with unmissable characteristics, especially for Hα line, and were first discussed more than 30 years ago. Our study is based on the spectral observations of samples of late B- and early A-type supergiants taken from the IACOB (archival database), the database of the 2m Perek telescope, and the database of Tartu Observatory. We bring new results about the nature of HVA events and promising hypotheses about the underlying mechanism.

Jiří Šilha, Matej Zigo, Peter Jevčák, Danica Žilková, Daniela Bartková, Tomáš Hrobár, Daniel Kyselica - *Space debris research at Comenius University*

In our work we will present the space debris research program conducted at our institute. The known attitude states of space objects are essential for Active Debris Removal and In-Orbit Servicing missions. We will discuss the rotation properties of space debris objects, related observations, and analysis. Space debris characterization is essential for understanding object's origin, creation mechanism and to estimate its impact on the space environment. Photometry and spectroscopy are the main methodologies applied to the space objects surface characterization. Utilized are photometric filters and spectrographs to understand how the light is reflected from the object's surface. In recent years, the space debris population, as well as the space traffic, rapidly increased. This leads to a dramatic surge of artificial objects re-entering the atmosphere creating meteor-like effects. These effects can be detected by nominal meteor detection systems such as the All-sky Meteor Orbit System (AMOS) operated by Comenius University in Bratislava, Slovakia. We will briefly discuss the example case of CZ-3B R/B re-entry event captured by the AMOS systems on the Haleakalā and Maunakea Observatories in Hawaii in October 2020. Space debris is becoming an issue for ground-based observations as well. It pollutes the night background sky and contributes to it's as a light pollution. We will present the data reduction of light curves extracted from the publicly available photometric catalogues. We will report estimated physical parameters such beta (diffuse vs specular reflection) and mean cross section multiplied by geometric albedo for more than 600 rotating objects including upper stages, non-functional spacecraft, and debris fragments for which we constructed the phase functions.

Matej Zigo, Jiří Šilha, Tomáš Hrobár - *Space weathering and aging effects observed on geostationary satellites*

Colour photometry is an effective technique for investigating the surface properties of space debris because it provides data on the object's spectral reflectance properties. The spectral reflectance properties of space debris are influenced by various factors, such as the object's composition, surface roughness, and exposure to the space environment. By analysing the colour indices of space debris, we can determine these properties and gain insights into the object's history and behaviour. We will present our approach for the investigations of the space weathering and aging effects based on the observational data. General planning constraints, data collection approach and data processing are discussed as well as the results obtain from observation of the satellite METEOSAT 11, which spent in orbit almost 9 years. All observations originated in the 70-centimeter Newtonian telescope installed at Astronomical and Geophysical observatory of Comenius university in Modra (AGO70).

Marianna Dafčíková - *Space weather effects at LEO as experienced by GRBAlpha*

GRBAlpha is a 1U CubeSat which aims to demonstrate the performance of a newly developed gamma-ray detector for future CAMELOT mission. Being on a low Earth polar orbit, GRBAlpha frequently passes through the Van Allen radiation belts. These regions are very dynamic, and their shape is predominantly determined by the interplanetary conditions which are subject to solar activity. As the Sun is headed to its maximum and more CubeSats are launched to LEO every year, it is crucial to have a proper understanding of how space weather affects the LEO environment. In this talk I will present the effects observed by GRBAlpha and discuss the possibility of an X1 solar flare destroying one of two radio transceivers on-board GRBAlpha.

Daniela Bartková, Jiří Šilha, Juraj Tóth - *Analysis of CZ-3B R/B re-entry event observed by all-sky camera system AMOS*

Large space debris objects descending to lower altitudes at which they start to break up under the influence of dynamic pressure create meteor-like phenomena when the ablation begins. A cluster of dozens of fragments was observed with All-Sky Meteor Orbit System (AMOS) over the Hawaiian Islands in October 2020, presumably produced by the break-up or explosion of the third stage of a Chinese Long March 3B rocket. Recorded positions from two all-sky cameras were measured and used for the trajectory reconstruction of 17 selected fragments. Details about this re-entry event and the ongoing analysis will be presented.

Radovan Lascsák - *Simulation of space debris removal by aerodynamic drag*

The amount of space debris in orbit is increasing, and various initiatives are being undertaken to control it. In this paper, we present an active method of removing space debris that is 1 cm in size. It is based on creating a small cloud of dust particles directly in space. The goal is to hit the debris at a high relative velocity, which will slow it down due to the drag force. That allows us to reduce the debris' orbital lifetime from hundreds of years to less than 25 years. We estimate that with a supply of 100 kg dust particles, it would be possible to remove over a thousand pieces of debris.

Patrik Čechvala, Jozef Masarik, Róbert Breier - *Exposure of extraterrestrial material to cosmic-ray particles*

Cosmic ray are high-energy particles, mainly protons and nuclei of different elements, propagating through the Universe. In our work, we simulate the exposure of extraterrestrial material to galactic cosmic-ray protons. Monte Carlo simulation software Geant4 is used. The spherical body of defined chemical composition, diameter and density is bombarded by protons of defined energy spectra with energies up to 20 GeV. The fluxes of secondary protons and neutrons are calculated in concentric layers with decreasing diameter. These fluxes are used for the calculation of the production rates of chosen cosmogenic nuclides.

S. Mackovjak - ***Opportunities for young astronomers at the Institute of Experimental Physics SAS***

Slovakia became an Associate member of the ESA just a few months ago. This opened new opportunities for students of astronomy from Slovakia. One of the potential destinations for young astronomers, where they can work on projects for ESA is the Institute of Experimental Physics, Slovak Academy of Sciences in Košice. During the contribution, the examples of cooperation between IEP SAS and ESA will be presented and the perspective topics for future projects will be outlined.

Pavol Valko - ***Satellites, spaceflight and universe, the amphitheatre for education***

The easiest way how to drive students (and ourselves) into deeper understanding of any subject, is to build upon proper motivation. Equally, it is too late to search for broad general education, while already being university student. Attempting to squeeze space-based motivation into physics (math, chemistry, informatics, …) classes at secondary schools is our attempt how to steer clear of student's aversion regarding "boring study". And this is indeed the goal of our ESA educational project.

Peter Butka, Šimon Mackovjak, Viera Krešňáková, Lenka Kališková - ***Automatic segmentation of different solar atmosphere structures by deep learning***

The main aim of the presentation is to describe our continuous effort with students in the use of deep learning for the segmentation of selected structures in the solar atmosphere. We started with U-Net architecture for the segmentation of coronal holes and active regions in images from SDO (Solar Dynamics Observatory), which we named SCSS-Net (Solar Corona Structure Segmentation Network). Due to the transferability of such approaches, we also decided to reuse architecture for images from SOHO (Solar and Heliospheric Observatory) and SUVI (Solar UltraViolet Imager). We were also able to apply a combination of our U-Net segmentation and morphological post-processing for the detection of interesting parallel structures of solar flares, which are often seen in the case of strong solar eruptions. We will also discuss future steps towards the potential usage of our algorithms in a more regular way as a service within the ESA Space Weather portal.

Šimon Mackovjak, Viera Krešňáková, Peter Butka, Matej Varga, Samuel Amrich, Adrián Kundrát, Silvia Kostárová - ***The Autonomous Service for Prediction of Ionospheric Scintillations (ASPIS) - Data analysis and preprocessing***

The state of ionosphere as part of atmosphere is most crucial for seamless communication between satellites in space and ground-based stations. If disturbance occurs, it can create amplitude and/or phase alternation in propagating signal. These disturbances are usually Rayleigh-Taylor instabilities. These alterations, referred to as ionospheric scintillations, pose a significant risk to the Global Navigation Satellite System (GNSS) signals. During scintillation events, GNSS receivers are getting a disturbed signal what lead to deterioration in accuracy or even in total loss of position information. Various physics-based models have been developed to simulate scintillation effects, relying on the theory of radio wave propagation in random media. Recent advancements in data-driven approaches utilizing machine learning techniques have introduced new capabilities in predicting ionospheric scintillations. A significant precedent was set by a study that utilized a machine learning technique called Support Vector Machine (SVM) to forecast high-latitude phase scintillation. Building upon this achievement, we have made the decision to develop an even more sophisticated and accurate model based on deep neural networks. To ensure the successful development of such a model, it is crucial to acquire and preprocess a sufficient amount of relevant data. This contribution primarily focuses on this aspect. The entire process can be divided into three stages. First is obtaining historical measurements from networks of GNSS receivers. Canadian High Arctic Ionospheric Network to be more precise (CHAIN). The next stage entails gathering, collecting, and filtering various parameters that describe the near space, solar activity, and Earth's magnetosphere. Lastly, the final stage encompasses binning and the development of an intelligent approach to link measurements with geographic positions and to combine multiple measurements effectively.

Viera Krešňáková, Šimon Mackovjak, Peter Butka, Matej Varga, Samuel Amrich, Adrian Kundrát, Silvia Kostarová - *The Autonomous Service for Prediction of Ionospheric Scintillations (ASPIS) - Developed Machine Learning models*

The Earth's ionosphere acts as the interface between terrestrial and space environments, a critical layer comprising charged particles, including electrons and ions. These constituents significantly influence the transmission of signals emanating from space satellites, with any perturbations in the ionosphere causing variations in the amplitude and phase of radio waves - a phenomenon known as ionospheric scintillation. Given the increasing dependence on space-based communication and navigation systems, predicting ionospheric scintillations effectively has become critically essential. The primary aim of our research, as part of the Autonomous Service for Prediction of Ionospheric Scintillations (ASPIS) project, is to offer a comprehensive theoretical overview of the potential application of deep learning methodologies within the realm of ionospheric scintillation prediction. Additionally, we aim to collate and scrutinize a breadth of relevant data suitable for developing an effective ionospheric scintillation prediction model. Our objective delves into developing a novel predictive model utilizing advanced deep neural networks. This model aims to offer spatio-temporal predictions of ionospheric scintillations with a lead time from 15 minutes to an hour, significantly improving the accuracy and responsiveness of such predictions, and thereby minimizing the adverse effects on communication and navigation systems. Through this research, we aspire to pave the way for the effective integration of artificial intelligence in the space science domain, contributing significantly to the overarching goals of the ASPIS project.

Lenka Kališková, Peter Butka, Viera Krešňáková, Šimon Mackovjak, Juraj Tóth, Pavol Zigo - *Applying YOLO for the detection of specific data within the field of astronomy*

The primary objective of this presentation is to discuss the techniques employed in detecting meteors and transient luminous events (TLEs). Meteors are observable phenomena that transpire when a meteoroid, comet, or asteroid enters the Earth's atmosphere, while TLEs are short-lived, electrically induced luminous plasmas occurring at high altitudes above cloud surfaces. In Slovakia, the Slovak Video Meteor Network effectively monitors TLEs through the implementation of the All-sky Meteor Orbit System (AMOS), which comprises a network of remotely operated semi-autonomous cameras. To detect meteors, we utilize two distinct sources. Firstly, the AMOS system captures the entire sky, enabling us to identify potential meteor occurrences. Secondly, we employ radio spectrograms from radar observations as an additional source for meteor detection. Our objective centers around the application of deep learning methodologies, particularly the You Only Look Once (YOLO) approach, to analyse the images obtained from AMOS cameras for meteor and TLE identification and also to analyse data from radio spectrograms for meteor detection.

Tomáš Ondro, Rudolf Gális - The thermal history of the intergalactic medium at 3.9 ≤ z ≤ 4.3

In this contribution, a new determination of the temperature of the intergalactic medium over 3.9 ≤ z ≤ 4.3 is presented. We applied the curvature method on a sample of 10 high resolution quasar spectra from the Ultraviolet and Visual Echelle Spectrograph on the VLT/ESO. We measured the temperature at mean density by determining the temperature at the characteristic overdensity, which is tight function of the absolute curvature irrespective of γ. Even though the results show no strong temperature evolution over the studied redshift range, our measurements are consistent with an intergalactic medium thermal history that includes a contribution from He II reionization.

Tomáš Ondro, Rudolf Gális – *TECO – Temperature evolution code*

For the generation of physically motivated thermal histories, one needs to perform computationally expensive cosmological simulations for a range of UVB models. Due to the needs of higher efficiency, we developed procedure named “Temperature evolution code" (TECO) for calculation of the temperature evolution of the intergalactic medium, which can be used to explore the parameter space of thermal histories. In this contribution, we present the applications of such a code for generation of various UVB models, and also as a post-processing tool of the N-body/SPH cosmological simulations (i.e., Gadget-2).

Nikolaos Samaras, Moritz Haslbauer, Pavel Kroupa - *Comparison of TNG Illustris simulations with Local Volume observations*

The IllustrisTNG project (https://www.tng-project.org/) is a set of large cosmological simulations tackling galaxy formation. Following the standard ΛCDM cosmology, we study the Star Formation Rate (SFR) of galaxies at the present time. We look at the Main Sequence of Galaxies (MS), a log-log plot of SFR against the Stellar mass. However, reviewing the observational data about a sample of Local Volume objects containing about 1000 galaxies within 11 Mpc of the Milky Way (I. D. Karachentsev, E. I. Kaisina 2019, arXiv:1905.08477), one could possibly uncover tension of the MS slope (MNRAS 485, 4817–4840 (2019)). We perform a detailed comparison of the model against observations, confirming the problems which disfavours a Dark-matter, Dark energy based universe.

Michal Šturc - *Testing MOND in the Solar neighbourhood*

It has been known for almost a century that the effect of visible matter can't account for motion of celestial objects on galactic and extragalactic scale. The conventional solution of this missing mass problem is to add dark matter. The other option is to change the way matter gravitationally interacts on low-acceleration scales. Since both approaches typically need to be tested on galactic or even extragalactic scales, the large timescales of motion in these systems make direct observations impractical. However, the components of a nearby triple star system 36 Ophiuchi are sufficiently distant from each other to be in the regime of low accelerations necessary for the use of the alternative approach. Numerical simulations suggest that the difference in separation between the components when using dark matter and the alternative approach is about 2 mas per 70 years, which is observable on human timescales.

Pavol Valko - *Gravitomagnetism vs. Dark Matter, in conjunction with GAIA & Euclid data*

Dark matter (DM), together with dark energy, are mysterious phenomena associated with both available observational data and current ΛCDM cosmological model. While DM have not been until now directly observed, future data from new missions promise to clarify DM situation. Gravitomagnetism, as a direct consequence of weak general relativity (GR) limit, may also have an important role in enlightening possible sources of DM associated effects. From that perspective, data from dedicated EUCLID space probe (currently under launch preparation), may well play a decisive role in DM phenomena understanding.

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