29th Young Scientists' Conference on Astronomy and Space Physics

Report of Contributions

https://indico.global/e/13390

Contribution ID: **1** Type: **not specified**

Official opening

Monday 24 April 2023 15:00 (30 minutes)

Contribution ID: **2** Type: **not specified**

High energy astrophysics and astroparticle physics

Contribution ID: **3** Type: **not specified**

Official closure

Friday 28 April 2023 14:25 (15 minutes)

Contribution ID: **4** Type: **not specified**

Be Stars as Binary Systems and Methods to Reveal the Secondary Components

Monday 24 April 2023 15:30 (45 minutes)

The presence of circumstellar matter was discovered over 150 years ago through visual observations of emission lines in spectra of B-type stars. This effect is called the Be phenomenon, found only in fast-rotating stars and not yet fully understood. One explanation of the fast rotation is a consequence of mass transfer from a secondary component, which have been hard to reveal because they are much fainter that the primary components, the B-type stars. Methods of detecting the secondary components include traditional (through an ultraviolet excess radiation due to a hotter secondary or regular radial velocity variations of the primary's spectral lines) and recently emerging ones (through regular variations of the peak intensities of typically double-peaked hydrogen emission-line profiles in the primary component spectra or deficit of far infrared fluxes compared to those calculated from models). I will discuss all the methods and show the results of recent studies that keep increasing the binary fraction of Galactic Be stars, many of which are very bright stars in our sky.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **5** Type: **not specified**

Origin of TIC 229741985 variability

Monday 24 April 2023 16:15 (15 minutes)

The shape of the light curve and the time scales of brightness variations are the main defining factors for classification of variable stars. However, different variability mechanisms can produce light curves of similar shape and period, hindering the determination of their origin. I will discuss the origin of TIC 229741985 variability. Based on TESS photometry, the star can be classified either as an eclipsing binary of W UMa type or delta Sct pulsator. By using TESS mission photometry, original spectroscopic observations, and database data I give a proof that the object cannot be a binary but a star of delta Sct. I will demonstrate the difficulties of the classification based purely on the single-band photometry.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **6** Type: **not specified**

Periodogram analysis from the data of the AAVSO database and the TESS space telescope of the semiregular variable star RX Leporis

Monday 24 April 2023 16:30 (15 minutes)

Authors: BARANSKY, A; Mr DZYGUNENKO, Andriy (Private institution of general secondary education Lyceum Kvinta Hromadska School, Gatne, Ukraine)

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **7** Type: **not specified**

GlobULeS-IV. UVIT/AstroSat detection of extremely low mass white dwarf companions to blue straggler stars in NGC 362

Monday 24 April 2023 17:05 (15 minutes)

Our study reports the discovery of ELM WDs as companions to BSS in the Galactic globular cluster NGC 362. We used data from AstroSat's UVIT, UVOT, Gaia EDR3, and the 2.2 m ESO/MPI telescope to create SEDs for 26 FUV bright member BSSs. Binary-SED fits revealed ELM WDs as binary companions in 12 of the 26 BSSs studied, suggesting that 12 BSSs are post-mass-transfer systems formed through the Case A/B mass transfer pathway. This is the first finding of ELM WDs as companions to BSS in globular clusters, and our results provide new insights into the dynamics of the NGC 362 cluster.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **8** Type: **not specified**

Variability of the Spin Period of the White Dwarf in the Intermediate Polar V405 Aur

Monday 24 April 2023 17:20 (15 minutes)

We present the results of photometric CCD observations of the magnetic cataclysmic variable V405 Aurigae obtained using different instruments. We analysed variability of the spin period of the white dwarf in this system using our observations and previously published maxima timings. We confirmed one of the 2 hypotheses of the spin period variability of this system published earlier. This system shows us a spin period increase and decrease during a couple decades of observations thus belongs to the list of the intermediate polars with complicated changes of spin period.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **9** Type: **not specified**

The Great Dimming of Betelgeuse: the atmosphere revealed by envelope tomography during the past 14 years

Monday 24 April 2023 17:35 (15 minutes)

"Betelgeuse, a red supergiant star of semi-regular variability, underwent a historical minimum of brightness in February 2020, the Great Dimming. Even though the brightness has returned to the values prior to the Great Dimming by now, it continues to exhibit highly unusual behavior.
Understanding the long-term atmospheric motions of Betelgeuse and its variability could be a clue to the nature of the Great Dimming. Our goal is to find evidence of what caused the Great Dimming.
We apply a tomographic method, which allows probing different layers in the stellar atmosphere, to reconstruct depth- dependent velocity fields. The method is based on constructing template spectra, called masks, by grouping spectral lines from specific optical depths. These masks are cross-correlated with the observed spectra to recover the velocity field inside each atmospheric slice.
Due to above 2000 spectra from 14 years, observed with the STELLA robotic telescope in Tenerife, we were able to analyse the variability of five different layers of Betelgeuse's atmosphere. The time variations of the widths of the cross-correlation function unveil propagation of two shock waves. We detected a previously reported shock wave that presumably caused the Great Dimming, and we report a following one, which was even stronger and continued to change the structure of the atmosphere. After the Great
Dimming, the dominant mode of pulsations changed. However, these changes did not take effect in all layers simultaneously. The inner layers started to pulsate with a shorter period of about 200 d, possibly the first overtone, while outer layers remained less affected, continuing their previous movement with the original period of about 400 d. The rearrangement of the photosphere was likely completed in 2022, when all the layers seemingly started to follow a similar behavior as before the Great Dimming, but now pulsating with the shorter period of about 200 d."

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **10** Type: **not specified**

Spin-down of He-rich CP stars

Monday 24 April 2023 17:50 (15 minutes)

About 10 % of upper main sequence stars, classified as chemically peculiar (CP) stars have anomalous abundance of chemical elements on their surface layers. A subgroup of hot CP stars with strong abundance of helium have not only a stellar wind, but also a strong magnetic field. The spin-down of these stars is probably caused by angular momentum loss through their magnetic stellar wind.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **11** Type: **not specified**

The chemical evolution of alpha-elements in the Milky Way

Monday 24 April 2023 18:05 (15 minutes)

The galactic chemical evolution (GCE) describes how the composition of a galaxy changes over time. This variation of the interstellar medium is due to the nuclear reactions in stars and supernovae that enrich the interstellar gas with heavy elements, as well as the inflowing gas from the extragalactic space. This field may be the most exciting when we study the history of the Milky Way, being such a debated area of astronomy.
Fortunately, stars enclose and preserve the composition of the interstellar gas when they are born. Thus when we analyze the composition of stars now visible across our galaxy, we can take a look back in time, how the elements in the interstellar gas formed and evolved. The APOGEE sky survey provides spectral abundances for many elements all across the Milky Way for almost 700 000 stars, creating an ideal dataset for this challenge.
The alpha-elements, produced in core-collapse supernovae are clear tracers of star formation in galaxies. APOGEE stars show a peculiar bimodality when plotting alpha-element abundances versus metallicities, which is a clear sign of two distinct star formation events, in accordance with the old thick and the young thin disk of the Milky Way. This can be most easily explained by two major gas infall events.
Many GCE models have been developed to follow the evolution of galaxies, out of which we used the open-source OMEGA+. By finetuning the model and its input parameters, we were able to match the observed chemical bimodality, for the first time with OMEGA+. This could only be done by assuming two infalls and by crucially constraining some key parameters, that can be of a big help to understand the history of our galaxy better.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **12** Type: **not specified**

Stellar Parameters of HD 60935

Monday 24 April 2023 18:30 (5 minutes)

In this study, we present preliminary stellar parameters of HD 60935 using the spectroscopic and photometric data. We obtained medium resolution spectroscopic data using the Shelyak spectrograph attached to the 0.4-meter telescope at Ankara University Kreiken Observatory. We utilized two methods to derive stellar parameters: the Bayesian Spectral Energy Distribution Model fitting for photometric data and stellar atmosphere models approaches for spectroscopic data. Stellar atmosphere parameters were derived using equivalent-width measurement and spectral synthesis methods. We also plotted the star on the H-R diagram and estimate its mass, age, radii, metallicity. Our result indicate that HD 60935 is a late type super-giant star with an age of around 0.8 billion years.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **13** Type: **not specified**

Photometric and Spectroscopic Study of BD-02 873

Monday 24 April 2023 18:20 (5 minutes)

This study, the first light curve analysis of BD-02 873, an spectroscopic binary star system, is presented. We obtained spectroscopic data using the Whoppshel spectrograph attached to the 0.8-meter telescope at Ankara University Kreiken Observatory to derive radial velocity. The light curve from the TESS data was combined with the radial velocity measurements and were analyzed using the PHOEBE light curve analysis program to determine orbital and physical parameters of the system. Simultaneous light and radial curve analysis show that the masses and radii for both components as $M1 = 1.23 M\odot$, $R1 = 1.66 R\odot$ and $M2 = 1.19 M\odot$, $R2 = 1.22 R\odot$ and the system has an eccentric orbit with $e = 0.14$.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **14** Type: **not specified**

Orbital Solution of Spectroscopic Binary: HD 10259

Monday 24 April 2023 18:25 (5 minutes)

Since 2007, the TUBITAK National Observatory (TUG) has been conducting precise Doppler surveys of G-K giant stars, which have identified several stars with radial velocities between 1 and 10 kms^{-1}. Among these stars is HD 10259, which exhibits a radial velocity variation with an amplitude of about 5 kms^{-1} over a period of 550 days. Using the 1.5m RTT150 telescope at TUG and an iodine (I_2) absorption cell, we obtained precise radial velocity measurements of the star and performed an orbital analysis to derive the system's orbital parameters. Our analysis revealed that HD 10259 is a single-lined spectroscopic binary with a very high eccentricity ($e \sim 0.65$). We also obtained a minimum mass of the component, which is estimated to be $m_2 sini \sim 0.21 M_{\odot}$.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **15** Type: **not specified**

Multi-wavelength study of outbursting cataclysmic variable star CRTS J033349.8-282244 in the LADUMA field using MeerKAT and MeerLICHT

Monday 24 April 2023 18:35 (5 minutes)

I will report on the optical-radio study of outbursting cataclysmic variable star CRTS J033349.8-282244 in the LADUMA field. The source has extensively been observed with multiple facilities. I will present the results from observations of CRTS J033349.8-282244 done with MeerLICHT, MeerKAT and SAAO telescopes throughout outbursts, super-outbursts and during quiescence. The LADUMA field is frequently observed by the MeerKAT radio array as well as MeerLICHT, which observes the field in multiple filters. This resulted in a unique dataset to study the colour evolution of CRTS J033349.8-282244 as a function of outburst phase across its many dwarf nova outbursts.

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Session Classification: Stellar astrophysics and interstellar medium

Contribution ID: **16** Type: **not specified**

Space debris and solar system bodies research at Comenius University Bratislava

Tuesday 25 April 2023 12:15 (45 minutes)

Research and scientific scope of the Division of Astronomy and Astrophysics, which belongs to the Department of Astronomy, Physics of the Earth and Meteorology, is focused on the interplanetary mass, physics and dynamics of small bodies of the Solar system, their relations and evolution and on modeling of the orbital evolution of the dust particles. Research also focuses on space debris and investigation of their dynamical, physical and reflectance characteristics. Here the emphasis is put on the application of the research in context of space safety activities. Additionally, quite extensive research is also dedicated to galactic astrophysics.
In our work we will present all the research programs conducted at our institute with extensive focus on space debris research. Space debris is becoming an issue for ground-based observations as well it pollutes the night background sky and contributes to its 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.
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 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 on October 24th 22:01 HST (October 25th 08:01:37 UTC). Preliminary results of the data reduction for the detected fragments will be presented.

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Session Classification: Solar System & extrasolar planets

Contribution ID: **17** Type: **not specified**

Quasi-simultaneous photometric, polarimetric, and spectral observations of Jupiter-family comet 108P/Ciffreo

Tuesday 25 April 2023 13:00 (15 minutes)

Comets of the Jupiter family are quite popular for study by both space missions and ground-based observations due to their orbits. This makes it possible to study these comets during their several approaches to the Sun and observe their evolutionary changes. The results of imaging photometric and long-slit spectroscopic observations of comet 108P/Ciffreo obtained in 2014 are presented. The observations of the comet were made at the 6-m telescope BTA SAO using the broad-band R filter. The low dust production Afρ=55±2 cm was obtained in the observational period of the comet. From the cometary spectra within the range 3800–7000 Å, emission features belonging to the C2, C3, and NH2 molecules were identified. In turn, morphologic analysis of photometric data applying digital filters showed the presence of asymmetrical coma, tail, and a slow-moving secondary object near the nucleus (the blob). A similar fragment was found by Kim et al. (2023) in the cometary coma based on observation in 2022. This structure probably results from a specific topography of the cometary nucleus, which may be responsible for the collimation of the jets and the formation of the observed blob.

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Session Classification: Solar System & extrasolar planets

Contribution ID: **18** Type: **not specified**

Photometry of dark asteroid (439) Ohio

Tuesday 25 April 2023 13:15 (15 minutes)

"Low-albedo asteroids are predominantly located on the outer part of the main belt and consist of the most primitive matter formed in the early stages of the formation of the Solar System. A detailed study of their surface structure and mineralogical composition can provide insight into the processes that formed the planets and other celestial bodies in our Solar System. One of the important characteristics that makes it possible to study the surface structure of asteroids and their optical properties is the magnitude-phase dependence. Only between of low-albedo asteroids there is a diversity of magnitude-phase dependences, especially in the region of the opposition effect (nonlinear increasing brightness at small phase angles), which indicates significant features in the surface structure of these bodies. Some of P and D-asteroids have no opposition effect, which means that their brightness is linearly down to very small phase angles. These objects, according to their spectra, represent the most primitive matter in the Solar System, which is characterized as very dark and contains organic materials. However, data on such asteroids are extremely insufficient, and further research of their surface properties is necessary to better understand their peculiarities.
This research focuses on the photometry of the asteroid (439) Ohio, a low-albedo asteroid with a slow rotation period. The aim of the work is to determine the rotation parameters of the asteroid, to improve the methods for determining the rotation period of slowly rotating asteroids and to obtain the magnitude-phase relation of this asteroid. The study involves processing of images obtained from CCD observations of the asteroid in V and R filters over 20 nights in 2020, to obtain asteroid lightcurves and absolute magnitudes. The rotation period of the asteroid was specified, equal to 37.4888 hours, and a composite lightcurve of the asteroid with an amplitude of 0.25 mag was constructed. This lightcurve has be used to obtain the resulting qualitative magnitude-phase dependence of the asteroid in the V and R filters, which do not show a nonlinear increasing brightness in the region of opposition effect.

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Session Classification: Solar System & extrasolar planets

Contribution ID: **19** Type: **not specified**

Phase- and color-ratio implementation results applying to dwarf planet Ceres and asteroid 4 Vesta surfaces

Tuesday 25 April 2023 13:30 (15 minutes)

"The phase-ratio method as well as color-ratio imagery was commonly used to identify structural changes of the upper regolith layer of the lunar surface, especially in the spacecraft landing sites. In the present it's possible to implement these methods to images of other planetary bodies due to extending number of space missions intended to provide remote sensing of planetary surfaces. Such opportunity is available for exploration of dwarf planet Ceres and asteroid 4 Vesta due to data obtained during NASA Dawn space mission. A large number of high-resolution images under various illumination and observation conditions reveals applying the method to both the biggest bodies in the main belt.

In our study we used Level 1b images obtained by instrument Framing Camera (FC) during HAMO and LAMO orbital phases. All images that were used in the research meet the main selection criteria.

In order to find areas that demonstrate an anomalous optical roughness several the most prominent regions on Ceres and Vesta surface were selected. Two regions on Ceres are small (up to 9 km in diameter) craters Xevioso and Oxo, both exhibiting bright material ejecta around their rim. Other two are Ahuna Mons (elliptical elevation with flat summit about 4 km in height) and Occator crater (D=90km) and also considered to bear the same bright material like the previous regions. On Vesta surface were selected regions around three craters (Vibidia, Laelia and Laeta) and one tholus (Aricia Tholus), within which are evidences of low-albedo material presence. Such material is usually associated with ejecta blankets around the crater and assumed to be exogenic.

For each region maps of phase- and color-ratio distribution were obtained. We obtained color ratios C(438nm/749nm) and C(749nm/917nm) for vestan regions and C(438nm/749nm) and C(749nm/965nm) for Ceres surface regions. Comparing phase-ratio distribution images with apparent albedo and color-ratio images provides an opportunity to find areas with anomalous optical roughness and chemical variations. Some of the results will be discussed during the meeting.

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Session Classification: Solar System & extrasolar planets

Contribution ID: **20** Type: **not specified**

Astrometry And Photometry Of The Dart Space Mission Object Asteroid (65803) Didymos In Lisnyky

Tuesday 25 April 2023 13:45 (5 minutes)

(65803) Didymos is a binary asteroid of spectral class S with a primary diameter of 0.78 km and a secondary diameter of 0.15 km. (65803) Didymos was the target of NASA's DART mission (2022), the Italian Space Agency's LICIA mission (2022), and is the target of the European Space Agency's upcoming Hera mission (2026).
In this work, we present the results of our observations (65803) Didymos on 16 and 1 Nowember 2022, when the object had a pronounced tail of particles after the DART impact on 26 September 2022. Our observations were obtained using a 0.7-meter (f/4) reflector AZT-8 and Moravian-C4 16000 CCD camera, in Johnson-Cousins V, R and I filters at the Lisnyky observatory station (Code MPC −585). For measurements, the Astrometrica 4 software was used with the Gaia DR2 star catalog. During the two nights, 80 images were taken, of which 73 were used for astrometric measurements, 60 for photometric measurements.

For 2022 10 16.06 (UT) 24 astrometric observations were published in circular MPS 1816756; mean RA residual $-0.2700.299$ dec $-$ 0.069 ± 0.184. For 2022 11 01.02 (UT) 49 observations were published in MPS 1729252; mean RA residual -0.131 ± 0.161 dec 0.023 ± 0.180.
The photometric part is to estimate the length of the visible tail formed after the impact with the DART. Results as of 2022 10 16: for V $(2'\ 10'' \pm 5'', PA\ \ 277,3 \pm 0,586°)$. Accordingly, for 2022 10 31: for V $(2'\ 12'' \pm 2'', PA\ \ 277,9 \pm 0,170°)$, R $(4'14'' \pm 2,5'', PA\ \ 277,3 \pm 0,164°)$, I $(2'28'' \pm 6'', PA\ \ 276,6 \pm 0,690°)$. The values of the visible tail in km 16.10.2022: for V $(10274 \pm 414km)$. Accordingly, for 31.10.2022: for V $(10359 \pm 161km)$, R $(20092 \pm 202km)$, I $(11668 \pm 495km)$.

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Session Classification: Solar System & extrasolar planets

Contribution ID: **21** Type: **not specified**

Modelling the Effects of Stellar Magnetic Fields on (Exo)Planetary Magnetosphere - Atmosphere systems with Implications for Habitability

Tuesday 25 April 2023 14:05 (15 minutes)

The long-term evolution of stellar magnetic activity governs the environment of the orbiting planets impacting their habitability. We perform three-dimensional magnetohydrodynamic simulations followed by a detailed parameter space study to understand the effect of variation in stellar wind magnetic field and intrinsic magnetosphere on the planetary magnetic field topology and atmospheric mass loss rate. We find that the relative strength of the planetary magnetic field with respect to that of stellar wind plays a critical role in determining the steady-state magnetospheric configuration and atmospheric erosion. Either strengthening the stellar wind magnetic field or weakening the planetary magnetospheric strength results in stellar field accumulation in front of the planet, similar to that of an imposed magnetosphere. We explore the formation of Alfvén wings on the planetary night-side wake region at different magnetic activity levels. We identify reconnection processes and wind conditions that lead to the bifurcation of the current sheet in the magnetotail. With increasing stellar wind magnetic field strength, the day-side reconnection point approaches the planet, thereby increasing the mass-loss rate. Our model results demonstrate the existence of an analytical relationship between atmospheric mass loss rate and ratio of planetary to stellar wind magnetic field strengths. Our study has far-reaching implications in the context of star-planet interaction and (exo)planetary habitability.

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Session Classification: Solar System & extrasolar planets

Contribution ID: **22** Type: **not specified**

Did Giant planets stated forming late in the Milky way?

Tuesday 25 April 2023 14:20 (15 minutes)

"In this study, we examine the kinematic and chemical features of the largest number of 2627 exoplanets harbouring stars whose parameters have been uniformly determined. We combine photometric, astrometric, and spectroscopic data from the most recent Gaia DR3 to examine the various populations of exoplanets harbouring stars. Using spectroscopic data, we determined that stars hosting massive planets are metal-rich and α-poor in comparison to stars hosting small planets. Kinematic analysis reveals that the host stars of small planets and giant planets differ in all aspects of galactic space velocity and orbital parameters. In addition, we find that small planet hosting stars have a marginally higher eccentricity and Z_{max} (an indication of an older population) than their larger counterparts. Our spectroscopic and kinematic studies suggest that the small and giant planetary systems likely belong to population of stars with different ages, giants being younger than the small ones. Using the PARSEC isochrone grids and isochrone fitting methods, we also estimated the ages of stars bearing exoplanets. All together, three analyses show that gas giants may have stared forming after the interstellar medium was enriched by Type Ia supernovae, which occurred late in the history of Milky Way. At the same time, a large spread seen in various age indicators of small planet hosting stars implies that they formed throughout the GCE. Despite the fact that several previous studies hinted at similar conclusions, they were not robust because to smaller sample sizes and/or inhomogeneous stellar parameter estimations. Due to the fact that our investigation was conducted on the largest sample of stars that host exoplanets, our results are currently the most credible.
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Session Classification: Solar System & extrasolar planets

Contribution ID: **23** Type: **not specified**

Precession of the orbital planes and rotational axes in transiting exoplanets

Tuesday 25 April 2023 14:35 (15 minutes)

"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 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 diploma thesis 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)."

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Session Classification: Solar System & extrasolar planets

Contribution ID: **24** Type: **not specified**

Analysis of combined light curves of selected stars with exoplanetary transits collected by Kepler and TESS orbital telescopes

Tuesday 25 April 2023 14:50 (15 minutes)

The analysis of the light curves of stars hosting planetary systems can potentially provide information about various physical processes taking place in the system: the physical variability of the star itself caused by pulsations, the rotation period of the star revealed by spots, the planet's orbital and rotation periods, etc. The data sets of the orbital telescopes Kepler and TESS (Transiting Exoplanet Survey Satellite) allow one to investigate both the exoplanets and their host stars with sub-mmag precision. Combining the two data sets obtained at different epochs and with different resolutions (sampling rates) enables expanding and supplementing the observation base for time series analysis. We present analysis of the light curves for stars from the KOI (Kepler Object of Interest) catalog, which were also observed by the TESS. The existence of the planets near the selected stars has not been confirmed yet, although the change in star brightness caused probably by a planet transit was recorded in the Kepler light curves. The Python package Lightkurve 2.3, which is freely available in the MUST (Barbara A. Mikulski Archive for Space Telescopes) archive, was used to process the light curves. The frequency spectrum was estimated based on the least-square fit of sinusoids to the data samples, similar to Fourier analysis as well as the Box Least Square Periodogram method. Some parameters (period, depth, duration) of the transit events have been extracted from the two data sets and compared. Another goal of our work is to derive the stellar rotation periods and compare them with the derived planet orbital periods, which may provide insight into the formation and evolution of planetary systems.

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Presenter: Ms LOBODENKO, Mariia (Faculty of Physics, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)

Session Classification: Solar System & extrasolar planets

Contribution ID: **25** Type: **not specified**

Flares, Coronal Mass Ejections and Solar Energetic Particles: new perspectives with the ESA Solar Orbiter mission

Wednesday 26 April 2023 14:30 (45 minutes)

“Our sun is a magnetic and active star. This has been known since the 17th century from the observations of sunspots at the solar surface. In the 19th century the solar sunspot cycle was discovered as well as the first impacts of disturbances of solar origin on the technology. This is in particular the case of the famous Carrington event on the 1st September 1859 at the Sun which led to the disruption of telegraphs for many hours after the event. Nowadays, our hi-tech world has become more and more vulnerable to disturbances from the Sun, in particular to the eruptive events associated with the release of magnetic energy in the solar atmosphere. Different phenomena related to solar activity can disturb our space environment: the amount of solar flux, in particular the ionizing solar flux impinging on the Earth, the level of geomagnetic activity induced in particular by gigantic coronal mass ejections which may reach the earth after a few days of propagation or the production of energetic particles associated with flares or coronal mass ejections that can reach the Earth’s orbit after a few tens of minutes to hours.

Although a lot of progress has been achieved since the advent of space missions to better understand the origin of solar activity and its impact on the heliosphere, many questions are still unsolved. The ESA Solar Orbiter mission was launched in February 2020 to provide unprecedented observations of our star’s surface, atmosphere and environment. I will present the main objectives of this new mission and of its 10 instruments designed to combine remote sensing observations of the solar atmosphere with in-situ measurements of the parameters of the ambient plasma. I will show some of the first observations of the mission and will then focus on the topic of particle acceleration in solar flares and transport from the solar corona towards the heliosphere. Energetic particles play indeed a major role in the active Sun because they contain a large amount of the magnetic energy released during flares. Energetic electrons and ions interact with the solar atmosphere and produce high-energy X-rays and γ-rays. Energetic particles can also escape to the corona and interplanetary medium, produce radio emissions (electrons) and may eventually reach the Earth’s orbit. It is currently admitted that solar flares are powered by magnetic energy previously stored in the coronal magnetic field and that magnetic energy release is likely to occur on coronal currents sheets along regions of strong gradient of magnetic connectivity. I will review our current understanding of particle acceleration and transport in solar flares and show first results on this topics obtained with Solar Orbiter X-ray and radio observations from the STIX and RPW instruments.
“

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Presenter: Dr VILMER, Nicole (LESIA-PSL Research University, Paris Observatory, Paris, France)

Session Classification: Solar physics and heliosphere

Contribution ID: **26** Type: **not specified**

Solar flare effect on the atmospheric infrasound

Wednesday 26 April 2023 15:15 (15 minutes)

The active region of the Sun 2673, which was localised in the southwestern part of the solar disc, with heliographic coordinates (S10 W30) on 6 September 2017, was the source of six solar flares, including two X-class flares: X2.2, which began at 08:57:00 UT and lasted 20 minutes, and X9.3, which began at 11:53:00 UT and lasted 17 minutes, according to NOAA GOES. At 12:06:05 UT, a CME with an angular width of 145° was registered according to SOHO LASCO.
The report shows the influence of solar activity on atmospheric infrasound using the data of solar disturbances. According to experimental data of the Karpenko Physico-mechanical institute of the NAS of Ukraine and Lviv centre of the Space research institute NAS of Ukraine and SSA of Ukraine 4 hours after the solar flares an increase of the intensity and atmospheric infrasound power spectrum width were registered.

Author: Mr IVANTYSHYN, Danylo (Lviv Polytechnic National University, Lviv, Ukraine)

Presenter: Mr IVANTYSHYN, Danylo (Lviv Polytechnic National University, Lviv, Ukraine)

Session Classification: Atmospheric studies and space geophysics

Contribution ID: **27** Type: **not specified**

Estimation of energy conversion rate during current sheet crossings

Wednesday 26 April 2023 15:30 (15 minutes)

Turbulence is a complex multiscale phenomenon that controls the transfer of energy, mass, and momentum in space plasmas. Dissipation is an important process of elimination of turbulent energy cascade rate at kinetic scales. In our work, we have considered multiple current sheet crossings to investigate scale features of turbulence dissipation in the Earth's magnetotail. Analysed measurements from the FPI and FIELDS instruments of the MMS (Magnetospheric Multiscale) Mission were used. We have applied single- and multi-spacecraft techniques to uncover dissipative scale features, and how dissipation converts eddies'energy into the plasma population.

This work was supported by grant No. 97742 of the Volkswagen Foundation (VW-Stiftung), the Royal Society International Exchanges Scheme 2021 (211177) and BF/30-2021.

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Session Classification: Atmospheric studies and space geophysics

Contribution ID: **28** Type: **not specified**

Observations and study of Hyper-Luminous Gamma-Ray Burst GRB 221009A at the Kyiv comet station

Wednesday 26 April 2023 16:00 (15 minutes)

GRB 221009A - hyper-luminous, long-duration gamma-ray burst (GRB) detected by Neil Gehrels Swift Observatory on October 9, 2022 and classified as the brightest GRB ever detected. In this work, we are presenting the results of our observations and photometric analysis of GRB221009A at the Kyiv comet station, as a part of international GRANDMA network (Global Rapid Advanced Network Devoted to the Multi-messenger addicts). Additionally, our study includes calculations of physical parameters and analysing the possibility of supernova association with this gamma-ray burst.

We observed the optical afterglow of GRB221009A on AZT-8 with Moravian-C4 16000 CCD camera, in Johnson-Cousins R and I filters. For photometric reduction of our data we used and investigated methods of transient object photometry in the following software: MaxIm DL, STDpipe (simple transient detection pipeline) and Astrometrica, using Pan-STARRS1, Gaia DR2 and USNO-B1 catalogs. Our first observation was obtained on 2022-10-10: 1.223 days after the trigger of Gamma-Ray Burst Monitor and the Large Area Telescope of the Fermi observatory. We continued observations the next five days, overall we obtained 371 images in R filter and 165 images in I filter with 30s or 60s exposure. In GRANDMA database we uploaded stacked images: 14 in R and 2 in I filters, with exposure from 300s to 6660s, for better object visibility. During this time, the brightness decreased from 18.31^m to 20.48^min the R filter and from 18.14^m to 20.13^m in the I filter. The photometric error varies from 0.03^m to 0.46^m (R filter) and from 0.01^m to 0.98^m (I filter). It was found experimentally that for the photometric system on the Kyiv Comet Station it is optimal to use comparison stars 1^m brighter than the object, relative to the largest magnitude during photometry in MaxIm DL. Additionally, it was calculated that the absorption of galactic dust for GRB221009A in the SF11 system is: Av = 4.1034^m, and for the SFD system: Av = 4.7714^m.

Based on peak energy value: Ep = 1060 keV, reported by GCN CIRCULAR 32668 and our results of photometry, we calculated physical parameters of GRB 221009A: M, L, Ep, z, $E\gamma$, iso, tb, z, $\Delta\Omega$, fb, $E\gamma$, $L\gamma, p, iso$, θj and Γ. We have obtained the value of isotropic bolometric peak luminosity $L\gamma, p, iso$ = $3.97{\cdot}10^{53}$ (erg s^-1) and isotropic bolometric emission energy $E\gamma, iso$ = $1.84{\cdot}10^{54}$ (erg), which place it among the most luminous gamma-ray bursts ever detected, more probably makes GRB221009A the most luminous GRB ever detected.

Author: Ms PYSHNA, Oleksandra (Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)

Presenter: Ms PYSHNA, Oleksandra (Astronomical Observatory of Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)

Session Classification: High energy astrophysics and astroparticle physics

Contribution ID: **29** Type: **not specified**

The curvature emission model of isolated X-ray pulsar RX J0420.0-5022.

Wednesday 26 April 2023 16:15 (15 minutes)

I construct a non-thermal emission theory, interpreting the observational properties of the isolated pulsar RX J0420.0-5022 in X-rays that is believed to be a thermally emitting isolated neutron star. This neutron star have previously been observed in soft X-rays to have nearly thermal spectra at temperatures , which are thought to arise from the warm neutron star surfaces. It is well-known that at a pulsar surface, the distribution function of relativistic particles is one-dimensional. However, cyclotron instability causes an appearance of transverse momenta of relativistic electrons, which as a result start to radiate in the synchrotron regime. This mechanism enables the generation optical and X-ray emissions on the light cylinder length scales. It is known, that the source spectrum is thermal. Considering a different approach to synchrotron emission theory, a spectral energy distribution was obtained, which was in a good agreement with the XMM-Newton observational data, which can be also successfully fitted with the pure Planckian spectral shape. We do not argue against the thermal emission scenario relying on spectral analysis results, as additional observational properties are acquired for distinguishing between existing emission scenarios. A fit to the X-ray spectrum was conducted using both the present synchrotron emission model spectrum absorbed by cold interstellar matter, as well as the generally assumed black-body absorption model. The work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNSFG) [FR-18-14747]

Author: Ms KEVLISHVILI, Natia (Institute of Theoretical Physics, Ilia State University, Tbilisi, Georgia)

Presenter: Ms KEVLISHVILI, Natia (Institute of Theoretical Physics, Ilia State University, Tbilisi, Georgia)

Session Classification: High energy astrophysics and astroparticle physics

Contribution ID: **30** Type: **not specified**

Multimessenger Research of Shapley Supercluster

Wednesday 26 April 2023 16:30 (15 minutes)

"The Shapley Supercluster is one of the largest and most massive structures in the nearby Universe at the distance of about 200 Mpc, consisting of thousands of galaxies. Multimessenger research has been a powerful tool in understanding the properties and evolution of this structure. The use of multiple messengers, such as electromagnetic radiation, high energy cosmic rays and neutrino, has allowed for a more complete understanding of the physics of the Shapley Supercluster, including its dynamics, particle acceleration, and dark matter content.
We present predicted spectra for neutrino and hadronic-induced diffuse gamma-ray emission of Shapley Supercluster."

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Session Classification: High energy astrophysics and astroparticle physics

Contribution ID: **31** Type: **not specified**

Tests of Hierarchical Accretion in the Virgo Cluster

Thursday 27 April 2023 12:10 (15 minutes)

Large concentrations of mass are now understood to be the products of a Hubble time's worth of merging and accretion. This history is preserved in the outer regions of galaxies' halos, where the dynamical scales are longer. This makes it possible to preserve fossil records of these events in the form of longlasting substructures imprinted in the physical properties of their stellar populations. In practice, this information is often hidden at surface brightness values below the sky.
Planetary Nebulae (PNe) can solve this observational challenge: owing to their strong [OIII] emission line—they are easily detected—PNe offer a unique tool to investigate low surface brightness regions and gather detailed observational proof of the structures' evolution.

In order to search for hierarchical processes, I analysed data from the Virgo Planetary Nebula Survey (VPNS) with the aim to study physical properties of its PN population and how they relate to the cluster properties as well as tracing variations in metallicity as a consequence of the presence of accretion events.

As a result, the different values of the PN α-parameter are consistent with a gradient from more metal rich stars in the galaxies' centres towards more metal poor populations of stars at large radii until the galaxy stellar population mixes with the IC component, consistent with a late built-up of the galaxies' halos. By comparing the α-parameter values of galaxies subject to environmental effects with those in close regions of intracluster (IC) regions, this work has shown that the Virgo intracluster light (ICL) is built up over time as a consequence of the tidal forces acting on both late- and small early-type galaxies. This, in turn, causes the ICL to be characterised by different metallicity values, especially in the north-west region where the IC component is highly unrelaxed.

With this work I also provided evidence for an unknown accretion event in the halo of the central galaxy, M87, that has caused an important modification of the metallicity of its outer stellar populations.

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Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **32** Type: **not specified**

Covering Factor in AGNs: Evolution or Selection?

Thursday 27 April 2023 12:25 (15 minutes)

Recent studies have reported on a possible evolution of the covering factor (CF) with redshift. The goal of the presentation is to answer the question if this evolution is real or whether selection effects play an important role. The presented analysis was based on cross-matched multiwavelength photometrical data from the five major surveys (SDSS, GALEX, UKIDSS, WISE, Spitzer). A sample of over 17,000 quasars was derived, and separated into two redshift bins –low-z and high-z. The data were further divided into smaller subsets based on the data quality. CF estimation used in our work was calculated from the ratio between dusty torus infrared luminosity (L[ir]) and the accretion disk optical luminosity (L[agn]), as it was postulated in the literature.

We found that the accuracy of the WISE W4 filter is problematic and, whenever possible, Spitzer MIPS 24 um should be used instead. This allowed us to reduce bias especially in the more distance sources. Luminosity evolution with redshift for both L[ir] and L[agn] was confirmed with the Efron&Petrosian test. The low-z and high-z samples follow, however, a similar correlation between L[agn] and L[ir]. The relation between L[ir]and L[agn] is slightly different than the 1:1 scaling, hinting for a more complex relationship between CF and L[agn], affected by possible contaminations. The individual components (stellar, dust and AGN among others) of spectral energy distribution (SED) were separated by SED fitting with the CIGALE code. The AGN emission was fitted with the SKIRTOR model. The SED fitting, enabled us to study possible contaminations in more detail, while also ensuring the alternative method for L[ir] and L[agn] estimations.

No evolution of the CF is detected based on the subsample within the high super-massive black hole mass bin, or with high luminosities: the low-z and high-z values of our CF estimator are found to have the same distribution.

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Presenter: Mr RAŁOWSKI, Mateusz (Jagiellonian University, Kraków, Poland)

Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **33** Type: **not specified**

Cosmological scalar field ΛCDM models

Thursday 27 April 2023 12:40 (15 minutes)

Cosmological models beyond the standard Lambda Cold Dark Matter (ΛCDM) scenario, namely the scalar field ΛCDM models are considered in this talk. The dynamics of the universe and the large-scale structure growth rate in these models in comparison with the standard spatially-flat ΛCDM model are investigated. Constraints on model parameters of ΛCDM models from various data sets are presented.

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Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **34** Type: **not specified**

Spectral energy distribution modeling of infrared bright galaxies

Thursday 27 April 2023 12:55 (15 minutes)

We present the detailed analysis of (U)LIRGs from ultraviolet through far-infrared to radio ($\sim$70\,MHz to $\sim$15\,GHz) bands. We derive the astrophysical properties through spectral energy distribution (SED) modeling using the Code Investigating GALaxy Emission (CIGALE) and UltraNest codes. The radio SEDs include our new observations at 325 and 610\,MHz from the GMRT and the measurements from public archives. Our main results are (1) radio SEDs show turnovers and bends, (2) the synchrotron spectral index of the fitted radio spectra ranges between -0.5 and -1.7, and (3) the infrared luminosity, dust mass, dust temperature, stellar mass, star-formation rates (SFRs) and AGN fraction obtained from CIGALE falls in
the range exhibited by galaxies of the same class. The ratio of 60μm infrared and 1.4\,GHz radio luminosity, the 1.4\,GHz thermal fraction, and emission measure range between 2.1 and 2.9, 0.1\% and 10\%, 0.02 and 269.5×10^{6}\,cm^{-6}\,pc, respectively. We conclude that the turnovers seen in the radio SEDs are due to free-free absorption; this is supported by the low AGN fraction derived from the CIGALE analysis. The decomposed 1.4\,GHz thermal and nonthermal radio luminosities allowed us to compute the star formation rate (SFR) using scaling relations.
A positive correlation is observed between the SFR$_{IR}$ obtained 10\,Myr ago (compared to 100\,Myr ago) and 1.4\,GHz radio (total and nonthermal) because similar synchrotron lifetimes are expected for typical magnetic field strengths observed in these galaxies ($\approx$50μG).

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Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **35** Type: **not specified**

MeerKAT follow-up of enigmatic radio sources in the G4Jy Sample

Thursday 27 April 2023 13:10 (15 minutes)

The GLEAM 4-Jy (G4Jy) Sample, formed from the GLEAM survey, comprises 1,863 of the brightest extragalactic radio-sources in the southern sky, the vast majority of which are active galactic nuclei with powerful radio jets. However, 140 of these sources have uncharacterised/ambiguous host galaxies due to the inadequate resolution (of 25 to 45-arcsec) of existing radio images. In this talk, I present key results from studying these 140 G4Jy sources These sources were observed with MeerKAT to assess their radio morphology and enable their host-galaxy identification through MeerKAT's higher resolution images. Our observations reveal a treasure trove of unusual radio sources: 5 of the 140 G4Jy sources have X-, S-/Z-shaped morphology, 10 have head-tail morphology, and 14 have a wide-angle tail (WAT) morphology. We report finding host galaxies for 98 of the 140 sources, leaving 42 with no identified host galaxy (Sejake et al., 2023).

Presenter: Ms SEJAKE, Precious (University of Pretoria, Hatfield, Gauteng, South Africa)

Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **36** Type: **not specified**

Multifrequency analysis of an X-shaped radio galaxy

Thursday 27 April 2023 13:40 (15 minutes)

The morphological evolution of winged radio galaxies are explained using several theoretical models, including galaxy mergers. However, such a direct link between a perturbed radio morphology and a galaxy merger remains observationally sparse. Here we investigate a unique X-shaped radio galaxy J1159+5820, whose host displays the optical signature of a post merger system. Multifrequency radio observations of the source were conducted and various particle injection models were fitted to its radio spectra. Spectral ageing analysis performed on the wings and lobes of the radio source favours a fast jet reorientation model. We will discuss here our results and possible mechanisms behind the formation of the radio structure.

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Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **37** Type: **not specified**

Mining Mini-Halos with MeerKAT I. Calibration and Imaging

Thursday 27 April 2023 13:55 (15 minutes)

Radio mini-halos are clouds of diffuse, low surface brightness synchrotron emission that surround the Brightest Cluster Galaxy (BCG) in massive cool-core galaxy clusters. In this paper, we use third generation calibration (3GC), also called direction-dependent (DD) calibration, and point source subtraction on MeerKAT extragalactic continuum data. We calibrate and image archival MeerKAT L-band observations of a sample of five galaxy clusters (ACO 1413, ACO 1795, ACO 3444, MACS J1115.8+0129, MACS J2140.2-2339). We use the CARACal pipeline for direction-independent (DI) calibration, DDFacet and killMS for 3GC, followed by visibility-plane point source subtraction to image the underlying mini-halo without bias from any embedded sources. Our 3GC process shows a drastic improvement in artefact removal, to the extent that the local noise around severely affected sources was halved and ultimately resulted in a 7\% improvement in global image noise. Thereafter, using these spectrally deconvolved Stokes I continuum images, we directly measure for four mini-halos the flux density, radio power, size and in-band integrated spectra. Further to that, we show the in-band spectral index maps of the mini-halo (with point sources). We present a new mini-halo detection hosted by MACS J2140.2-2339, having flux density $S_{1.28\,\mathrm{GHz}} = 2.61 \pm 0.31$ mJy, average diameter 296 kpc and $\alpha_{1\,\mathrm{GHz}}^{1.5\,\mathrm{GHz}} = 1.21 \pm 0.36$. We also found a $\sim$100 kpc southern extension to the ACO 3444 mini-halo which was not detected in previous VLA L-band observations. Our description of MeerKAT wide-field, wide-band data reduction will be instructive for conducting further mini-halo science.

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Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **38** Type: **not specified**

Relaxation of self-gravitating systems on a long time scale according to the results of direct numerical simulation

Thursday 27 April 2023 14:10 (15 minutes)

In our project we investigate the long term relaxation processes in the initially equilibrium self gravitating stellar systems. As an initial condition for our model star cluster we use the well described and well studied Plummer mass distribution (Plummer, 1911, MNRAS, 71, 460). We try to cover a wide range of observable stellar clusters in our Galaxy, so we generate the models starting from 16k particles (star cluster with ˜9200 \(M_\odot\)) up to 128k particles (star cluster with ˜73000 \(M_\odot\)). After the initial initialization of the system (give to each point mass the virial equilibrium 3D coordinates and velocities) we start our N-body direct summation and individual time step 4th order Hermite integration. As a basic code we use the publicly available version of phi-GPU: https://github.com/berczik/phi-GPU-mole program. For the unit normalization of our runs we use the commonly accepted, so-called, "N-body units"or "Henon units"(Aarseth, Henon, Wielen, 1974, A&A, 37, 183). In each timestep of our time integration we check the total energy (kinetic + potential) of each particle and compare these values with the initial values for the same particles. In the end we obtain the relative energy change distribution for each particle and for each timestep. Based on our energy changes analysis we estimate the relaxation time for each of our model stellar systems. From the obtained numerical results we construct the numerical fitt formula and compare this equation with the well known Spitzer equation (Spitzer, 1987, Princeton University Press. p. 191).

Presenter: Mr HRADOV, Mykola (Faculty of Physics, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine)

Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **39** Type: **not specified**

Merger identification through photometric bands, colours, and their errors

Thursday 27 April 2023 14:25 (15 minutes)

On our research we attempt to identify galaxy mergers in modern galaxy surveys. The main results we want to show in this presentation is how we used Machine Learning (ML) to learn a previously unknown photometric property of galaxy mergers.
We built a Neural Network that we trained on photometric measurements from SDSS, using a class-balanced dataset composed by mergers from Darg et al. (2010) and non-mergers from galaxies with low merger vote fractions in Galaxy Zoo. These sources were extracted from SDSS DR6 and GZ DR1. The result of the NN training showed that we could use the error in the sky background estimation to find them, achieving a 92.6 ± 0.2 % training accuracy in the validation set and 92.4 ± 0.2 % in the test set. Further analysis of the data showed that, by plotting this sky background error in the g versus r bands plane, a clear separation between mergers and non-mergers is revealed. By drawing a decision boundary a 91.6 % accuracy was achieved. Our interpretation is that it seems that the sky error traces the low S/N material tidally stripped by the merging interactions. This work shows not only an example of the strength of ML methods in galactic evolution studies but also the scientific interest in the interpretation of these methods internal properties. The paper on which this work is based has been published in A&A (https://arxiv.org/abs/2211.07489). Moreover, further research has been done on understanding how the sky error behaves in a dataset less ideal than the initial training set, showing how much contamination by blending sources or visual pairs can be expected using SDSS DR6 and GZ DR1.

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Presenter: Mr SUELVES, Luis (National Center for Nuclear Research, Poland)

Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **40** Type: **not specified**

Accelerating reionization simulations using machine learning

Thursday 27 April 2023 14:40 (15 minutes)

Semi-numerical simulations are the leading candidates for evolving reionization on cosmological scales. These semi-numerical models are efficient in generating large-scale maps of the 21cm signal, but they are too slow to enable inference at the field level. We present different strategies to train machine learning models to accelerate these simulations. We derive the ionization field directly from the initial density field without using the ionizing sources' location, and hence emulating the radiative transfer process. We find that the Unet model achieves higher accuracy in reconstructing the ionization field if the input includes either white noise or a noisy version of the ionization map beside the density field during training. Our model reconstructs the power spectrum over all scales perfectly well. This work represents a step towards generating large-scale ionization maps with a minimal cost and hence enabling rapid parameter inference at the field level

Author: Ms MASIPA, Mosima Portia

Presenter: Ms MASIPA, Mosima Portia

Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **41** Type: **not specified**

Application of machine learning methods to multiwavelength photometric catalogs

Thursday 27 April 2023 14:55 (15 minutes)

"The aim of this presentation is to show how machine learning techniques can be used for the task of object selection in multiwavelength photometric data. Here, I present a model for automatic active galactic nuclei (AGN) selection in the combined optical and near-IR photometric catalog based on the data from the deep sky survey in the AKARI NEP-Wide field. Specific construction of the classification model shows it is possible to create a method which will be able to mimic mid-IR based photometric AGN selection using only optical and near-IR broadband photometry. The described model can preserve efficiency similar to mid-IR techniques. However, it allows one to obtain much larger catalogs due to the lack of mid-IR detection conditions.
Methods developed in this work overcome detector limitations and allow one to precisely control the quality of the final source catalog. Moreover, a user of this method can identify different sources of catalog contamination. These properties were achieved by a combination of specific construction of the training sample, which allowed us to indirectly impose information about the mid-IR selection into the structure of the ML model, avoidance of extrapolation risk during classification of unlabeled objects and application of unsupervised learning methods to identify sources of catalog contamination.
Presented techniques allow one to match catalog properties to specific scientific needs, making them an effective and versatile tool for modern astrophysics."

Presenter: Dr POLISZCZUK, Artem (Stanford University, USA)

Session Classification: Extragalactic astrophysics and cosmology

Contribution ID: **42** Type: **not specified**

Astroinformatics: Periodogram Analysis of Astronomical Signals

Friday 28 April 2023 12:10 (45 minutes)

"Different algorithms for periodogram analysis are reviewed. The mathematically strong definition is that, for a periodical signal $x(t) = x(t + m * P)$, for each moment of Time t. The period is the minimal value, for which this equation is satisfied for all integer values of m.
For regularly distributed discrete moments of time $t_k = t_0 + k * \delta$, with a time step (=time resolution) δ, the number of observation k, the period may be $P = n * \delta/m$, where n is the number of observations, and $m = 1..\mathrm{int}(\mathrm{n}/2)$. Such simplest case allows using very popular methods like a Fourier Transform (FT) (originating from the famous work of Jean Baptiste Joseph Fourier published in 1822), an Auto-Correlation Analysis (ACF) and their numerous modifications. Astronomical Time Series (TS) are generally not regular in time. Even special space missions like KEPLER or TESS, with an excellent accuracy, produce TS with some gaps. Other photometric surveys often contain sparse data. In this case, other methods are needed beyond these oversimplified ones. One of group of methods uses only "moments of characteristic events"(e.g. times of maxima or minima (ToM)), For statistically optimal determination of ToMs, the software MAVKA (http://uavso.org.ua/mavka) is used, where 11 types of functions (21 functions totally) may be realized. The review of methods to determine a period is in 1988AN....309..121A .
For using all the (sparse) data, there is a large group of methods based on a determination of a maximum (or minimum) of some test function $\Theta(t_k, x_k, k = 1..n; P, T_0)$, which characterizes a "goodness"of the phase curve $x_k(\phi_k)$, where the phase $\phi_k = \mathrm{TRUNC}((t_k - T_0)/P)$.
These methods may be divided into two large subgroups. The first one is the so-called "Non-parametric"or "point-point"methods. The test function characterizes the "effective distance between the points, which are subsequent in phase (see a review 1997KFNT...13f..67A) or at least a group of points close in phase. No approximation is made, no parameters are determined. The second group of the methods, alternately, are called "parametric"or "point-curve"methods and are based on (generally, weighted) least squares approximation (LSQ). The approximations proposed range from a usual cosine to polynomial (or non-polynomial) splines (special functions/shapes/patterns).
We argue for using complete mathematical models, instead of over-simplified ("step-by-step) ones (like "mean/trend removal"(="detrending"), "pre-whitening"etc.), to avoid possible large bias of the parameters.An effective tool for an analysis of (multi-periodic) (multi-) harmonic signals is the program MCV ("Multi-Column Viewer) at http://uavso.org.ua/mcv/MCV.zip .
Such approximations are called the "phenomenological"ones, as the number of determined parameters may be significantly larger than that needed for the "physical"modeling (which may need models of unstable stellar atmospheres with a huge number of physical parameters). They are effective for photometric data, especially, of a newly discovered variables, A recent review is in 2020kdbd.book..191A .
We illustrate these methods with applications to variable stars of different types - pulsating (of types M, SR, RV, δ Cep, RR) and binary (eclipsing, cataclysmic, symbiotic)."

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Session Classification: Data collection and analysis

Contribution ID: **43** Type: **not specified**

Astroinformatics: program for scale-adaptive running sine approximation with trend. Application to S Ori

Friday 28 April 2023 12:55 (15 minutes)

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Session Classification: Data collection and analysis

Contribution ID: **44** Type: **not specified**

Strong Lens Detection 2.0: Machine Learning and Transformer Models

Friday 28 April 2023 13:10 (15 minutes)

The upcoming large-scale astronomical surveys, such as the Rubin Observatory Legacy Survey of Space and Time, are expected to detect approximately 10^5 strong gravitational lenses. However, traditional, non-automated techniques for detecting these lenses are highly time-consuming and impractical for analyzing data on such a large scale. To tackle this issue, we propose a new machine-learning technique known as Transformers. We have compared Transformers and current state-of-the-art Convolutional Neural Networks (CNNs) using data from the Bologna Lens Challenge 1.0 and 2.0 and found that Transformers can be an effective alternative for detecting strong gravitational lenses. The transformer models outperformed all the CNNs that participated in both challenges. Self-attention-based models, such as Transformers, have several advantages over simpler CNNs. They can identify lensing candidates with a high level of confidence and can effectively filter out potential candidates from real data. Additionally, using self-attention layers in Transformers also reduces the problem of overfitting commonly encountered with CNNs.

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Session Classification: Data collection and analysis

Contribution ID: **45** Type: **not specified**

A Solar Imaging Pipeline for MeerKAT

Friday 28 April 2023 13:40 (15 minutes)

Most radio astronomers consider the Sun a nuisance, being considered one of the biggest sources of RFI in MeerKAT observations. The MeerKAT radio telescope is a precursor radio interferometer for the Square Kilometre Array (SKA) mid frequency telescope, that is located in the arid Karoo region of the Northern Cape Province, in South Africa (at 21 degrees East, 30 degrees South) (Jonas and MeerKAT Team, 2016). It will be the most sensitive decimetre-wavelength radio interferometer array in the world before the SKA1-mid. MeerKAT is an interferometer composed of 64 antennas with 13.5 m of diameter and the maximum baseline within antennas is 8 km (Abbate, 2021). MeerKAT operates in UHF band (580-1015 MHz) as well as L-band (856-1712 MHz), with S-band (1.75 - 3.5 GHz) currently being commissioned and Solar interference is likely to be stronger in UHF band (Jonas and MeerKAT Team, 2016). The Sun is such a strong source of radio emission (Hey, 1973) that solar fringes can readily be seen on individual baselines of the MeerKAT telescope, and the solar disk has even been successfully imaged when the telescope was pointing almost 90 degrees away from it. Aside from observations where the Sun is very close to the optical axis of the telescope, the observing conditions that lead to the most prominent solar interference are not thoroughly understood and this is one of the solutions that can be obtained through this project.

The goal of this project is to build an automated pipeline that is able, through MeerKAT observations, to determine the location of the Sun in relation to the antenna orientations and the celestial coordinates of the targets, Image the Sun, characterise the strength of the solar contamination and remove the Sun from the observations.
These results will be used to influence the scheduling strategies of MeerKAT and SKA-MID. A natural by-product of this work will be many images and movies that resolve the solar disk and its complexes of sunspots.

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Session Classification: Data collection and analysis

Contribution ID: **46** Type: **not specified**

Information system for studying space weather parameters

Friday 28 April 2023 13:55 (15 minutes)

Studies of the Sun and solar-terrestrial relations are carried out by a significant number of both ground-based and space-based observational instruments, as a result, data on solar activity indices, geophysical disturbance indices, information on galactic cosmic rays are stored in different formats and different servers, which complicates the work with such data. The report presents the architecture of an information system for studying space weather parameters.
A client-server information system consists of three main components: server software; end-user software; and application software. With the help of this software, users establish communication with the server, form queries that are automatically generated into DBMS queries and sent to the server. The server is responsible for storing, modifying, selecting, and deleting data related to solving an application task, accepting and processing queries, and then transmitting the results to clients.

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Session Classification: Data collection and analysis

Contribution ID: **47** Type: **not specified**

The future of Astronomy in Ukraine: EARG's and TESS space telescope

Friday 28 April 2023 14:10 (15 minutes)

Our team are professional astronomers who are currently focused on saving and rebuilding Astronomy in Ukraine, where this science is in a terrible state right now. Our first step was to create experimental astronomical research groups (EARG). Those EARG's mostly consists of students aged 15-25 and their aim is to implement brand new methods of astronomical research, as well as publish articles in peer-reviewed journals.
Inside those EARG's our students work individually, studying theory, choosing their objects of interest, processing photometric data of TESS space telescope, making discoveries, creating the paper and submitting to the journal. As the objects of interest, we chose variable stars as relatively simple and highly-demanded type of research (especially in the fields of asteroseismology and exoplanet search). Due to high level of methods and algorithm unification it is possible for each professor to make research with up to 15 students simultaneously. After 5+ month each student who succeeded, receives: basic knowledge about variable stars in general, advanced knowledge about a specific type of stars, an article in a peer-reviewed journal and an oral contribution on a local conference. Our first project called "TESS-UA-2022"attracted 11 students (7 finished). Now we improved it and scaled up to 56 students ("TESS-UA-2023A").
Those EARG's are under constant development and if successful years later they might be adjusted and used to improve astronomical education in many developing countries of Africa and Central Asia.

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