XX SERBIAN ASTRONOMICAL CONFERENCE

October 16 - 20, 2023, Belgrade, Serbia

BOOK OF ABSTRACTS

Eds. Jelena Petrović, Dušan Marčeta and Ana Lalović

Belgrade 2023

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Invited Review

VARIABILITY OF AGN

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I will begin with a brief introduction to general aspects of Active Galactic Nuclei (AGN) variability. Then I will focus on two aspects: What about AGN that show extreme variability amplitudes in the optical and X-rays. The second aspect is the (optical) spectral line variability: What can we learn from this about the geometry and kinematics in the innermost regions that are surrounding the central supermassive black holes in AGN.

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Invited Review

SUPERNOVAE AS TRACERS OF THE STRUCTURE AND EVOLUTION OF THE SURROUNDING UNIVERSE

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The impact of mass lost from hot stars in general, including supernovae (SNe) as probably the leading contributor, has a direct impact on the evolution not only of stars but the entire universe. We study the interactions of expanding supernova (SN) envelopes with aspherical dense circumstellar medium (CSM) of various shapes and stratifications, including, for example, circumstellar disk, bipolar lobes, or thickened layers of colliding ejected matter in binary systems. Many possible mechanisms can lead to wild eruptions of vast amounts of matter from potential SNe progenitors, for a long time or shortly before the SN explosion itself. Exact nature of these processes is still unclear. After the explosion, the propagation of the SN shock wave through such environment leads to significant effects that fundamentally increase the luminosity and duration of the light curve. They also cause characteristic light curve irregularities, including sudden rebrightenings or luminosity bumps. These effects can also be manifested by remarkable asymmetries in the spectra if observed from different directions. We used our advanced multidimensional radiative-hydrodynamic code to simulate gas dynamics in shock wave regions and quantify the shock thermal energy released during such interactions. Using a 3D radiative transport code, we calculated the light curves and spectral profiles of these different SN-CSM configurations from different observational directions at various stages of expansion. By comparing the shapes and evolution of observable characteristics calculated in our models and their values with those observed, we can estimate the amount and spatial distribution of the mass ejected before the explosion. This may further contribute to describing the interstellar matter distribution and understanding the mechanisms of powerful outflows or extremely violent eruptions by which this matter ejects from stars approaching their death into space. Since massive stars ending their lives as SNe appear to be prime candidates for neutron stars, black holes, gamma-ray bursts, and even magnetars, quantification and understanding of the behavior of the processes shortly before and after their SN explosions and their impact on the surroundings will potentially help us understand how hot stars become precursors to these exotic and interesting stellar objects.

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Invited Review

PER ASPERA AD ASTRA

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I will review the latest results from the next generation of telescopes and put them in context of modern society and culture. Everything that you ever wanted to know about Science and scared to ask? The origin of life, universe and the future of Earth. What can we learn about so special planet Earth its inhabitants and the nearby Universe. And, how to survive and live forever?

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Invited Review

MONITORING BLAZAR VARIABILITY TO UNDERSTAND EXTRAGALACTIC JETS

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Active galactic nuclei (AGN) are the most luminous persistent sources in the universe. A minority of AGN are characterized by powerful plasma jets extending from close to the supermassive black hole at the center of their host galaxy up to megaparsec scales in the intergalactic space. Inside these jets, charged particles are accelerated to relativistic speeds and emit non-thermal radiation. In blazars one jet is oriented at a small angle with respect to the line of sight, and this causes Doppler beaming of the jet emission, with consequent flux enhancement and decrease of the variability time scales. The dominant contribution of the jet radiation to the blazar emission makes these objects ideal sources to investigate what happens in the inner regions of extragalactic jets and even what is the jet structure and dynamics. We will report on the results we have obtained by monitoring blazars in a multiwavelength context through the Whole Blazar Telescope (WEBT) Collaboration, involving many tens of astronomers around the world, including researchers from the Astronomical Observatory of Belgrade.

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Invited Review

BAIKAL-GVD NEUTRINO TELESCOPE: UNLOCKING THE SECRETS OF THE UNIVERSE'S CATASTROPHIC EVENTS

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The Baikal-GVD Neutrino Telescope represents a cutting-edge scientific endeavor, driven by the pursuit of observing and identifying the elusive sources of ultra high energy neutrinos. These neutrinos serve as crucial messengers, carrying vital information about catastrophic events unfolding across the vast expanses of the Universe. The Baikal-GVD Collaboration is committed to construct a cubic kilometer-sized underwater 3D infrastructure. This facility will boast advanced optical modules, acoustic modems, lasers, and a range of calibration and monitoring devices. Remarkably, the current effective volume of the neutrino telescope in Lake Baikal has reached 0.6 km ^{3}, specifically for showering events initiated by neutrinos with energies surpassing 100 TeV. This achievement firmly establishes Baikal-GVD as the largest neutrino telescope in the Northern hemisphere. Our discussion will delve into the present status and future prospects of this extraordinary detector, shining a spotlight on the scientific results that have already been obtained through its operation.

Invited Lecture

CURRENT STATUS AND FUTURE PROSPECTS OF THREE-FLAVOR OSCILLATIONS' MEASUREMENTS WITH ACCELERATOR NEUTRINO BEAMS

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Current status and future prospects of three-flavor oscillations' measurements with accelerator neutrino beams Neutrino oscillation physics developed rapidly during the last couple of decades. Although, there are still unmeasured parameters that define this process. These measurements are a primary goal of current and future projects in this area of particle physics. The talk will be devoted to the discussion of currently running accelerator neutrino experiments that are measuring three-flavor neutrino oscillations (NOvA and T2K) and briefly describe the prospects of future experiments (DUNE and Hyper-Kamiokande) and possible projects that are under consideration these days.

Invited Lecture

NUCLEAR SPECTROSCOPY, NEUTRINO PHYSICS AND ASTROPHYSICS

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The talk will give a review of connection between classical nuclear spectroscopy on the modern level, low energy neutrino physics and astrophysics on base of experiments conducted at the Laboratory of nuclear problems, JINR (Dubna, Russia). The laboratory is well known for participation in world leading experiments for search and study different rare processes by methods of nuclear spectrometry. The particular experiments which will be discussed are search for neutrinoless double beta decay, study of neutrino sector with reactor neutrinos, direct search for dark matter and axions.

Invited Lecture

DIRECT SEARCH FOR DARK MATTER IN UNDERGROUND EXPERIMENTS

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The talk will give a review of the modern state in direct experimental search for Dark Matter particles. The talk will be mainly focus on the methods and approaches used in the experiments. The reduction of background level is one of the most important tasks in all such projects. The particular experience in background reduction and study accumulated in DLNP. JINR (Dubna, Russia) will be presented. Some recent results will be also discussed.

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Invited Lecture

LONG AND MEDIUM BASELINE EXPERIMENTS WITH REACTOR ANTINEUTRINOS

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The experiments with reactor electron antineutrinos are playing an important role in the precision measurements of neutrino oscillation parameters. While relevant antineutrino energies are relatively low and cover a range from 1.8 MeV to around 8 MeV, which is not sufficient to observe the creation of other neutrino flavors, the distortion of the observed energy spectrum enables scientists to unambiguously measure 4 oscillation parameters by placing detectors at 3 special characteristic distances from the reactors. The talk covers the precision measurement of neutrino squared mass difference $\mid \Delta m^2_{21} \mid$ in the KamLAND experiment on average distance of 180 km from the reactors in Japan; the observation of neutrino mixing angle θ_{13} and high precision measurement of θ_{13} and $\mid \Delta m^2_{32} \mid$ (or $\mid \Delta m^2_{31} \mid$) at a distance around 1.5 km by the Daya Bay (China), RENO (Korea) and Double CHOOZ (France) experiments. Finally the talk will describe the JUNO experiment with a baseline of 52.5 km, which is currently under construction in China. The goal of JUNO is to determine the neutrino mass ordering (the sign of $\mid \Delta m^2_{32} \mid$ or $\mid \Delta m^2_{31} \mid$) at the level of 3σ after 6 years of data taking and without external constraints. JUNO will measure $\mid \Delta m^2_{31} \mid$, $\mid \Delta m^2_{21} \mid$ and $\sin^2 2\theta_{12}$ with precision better than 0.5%. Some attention will be paid to the overall physics programme of the JUNO experiment, not limited to the reactor antineutrinos.

Invited Lecture

ORIGIN OF THE DIVERSITY OF ROTATIONAL SUPPORT OF EARLY-TYPE GALAXIES

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Early-type galaxies (i.e. elliptical and lenticular) are divided into slow and fast rotators according to the appearance of their maps of line-of-sight velocity. Fast rotators show clear ordered rotation, while slow are supported mostly by velocity dispersion. I will present our investigations of the origin of this diversity. Inspired by cosmological simulations, we assumed that galaxies first form with a high rotational support, which is later decreased by mergers, and wanted to learn more about these mergers. We investigated the correlations of a measure of rotational support with various properties of galaxies that are sensitive to mergers. These include stellar ages, the presence of tidal features, and kinematically distinct cores. Each of these parameters is sensitive to a different type of merger and has a different lifetime. The found correlations, or their lack, together with observations of high-redshift universe, are explained the easiest, if the rotation support of early-type galaxies was decreased by multiple minor wet mergers more than 10 Gyr ago.

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Invited Lecture

HOW PHASE-SPACE CORRELATIONS OF SYSTEMS OF SATELLITE GALAXIES CHALLENGE ΛCDM COSMOLOGY

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Driven by the increasingly complete observational knowledge of systems of satellite galaxies, mutual spatial alignments and relations in velocities among satellites belonging to a common host have become a productive field of research. The Planes of Satellite Galaxies issue is maybe the best-known type of such phase-space correlations, with an ongoing, controversial debate on how much of a challenge it poses for the ΛCDM model of cosmology. With the fast expansion of proper motion measurements in recent years, largely driven by the Gaia mission, other peculiar phase-space correlations have been uncovered among the satellites of the Milky Way. At the same time, more complete observational samples of satellite galaxies around more distant hosts now enable us to expand the study such correlations to the Andromeda galaxy and beyond. In my talk, I will provide an introduction to the highly active field of phase-space correlations among satellite galaxy systems and review some of our recent results concerning planes of satellite galaxies, lopsided satellite galaxy systems, pair- and group-wise correlations and how these compare to cosmological expectations and other suggested origins of satellite galaxies.

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Progress Report

SPECIFIC ANGULAR MOMENTUM CORRELATION WITH THE NUMBER OF SATELLITES

Ana Lalović, Milena Jovanović, Slađana Knežević, Srđan Samurović

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The number of satellites is correlated with the mass of the galaxy bulge and bulge-to-total ratio, indicating that the origin of satellites might be related to the mechanism responsible for bulge creation/growth. In this work we have found that specific angular momentum correlates positively with the number of satellites for a sample of six nearby galaxies for which we have complete census of satellite population. Contrary to previous work where this correlation is found to be negative using an approximate formula for specific angular momentum, in this work we have measured specific angular momentum more thoroughly: using both rotation curve data and galaxy mass distribution in the near infrared. Disagreement can be explained by the difference between approximate and more accurate measurement of angular momentum.

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Invited Lecture

BARYONIC MASS IN NEARBY GALAXIES (PHD THESIS)

Milena Jovanović

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In my doctoral research, I utilized high-resolution observations from the HI Nearby Galaxy Survey (THINGS) to model the dynamical and baryonic mass distributions of nearby galaxies. These observations of neutral atomic hydrogen, boasting extensive data, enabled us to extract the rotation curve, thereby deducing the total dynamical mass up to a significant radius. In conjunction with infrared observations, we concurrently fit the dynamical mass with the observed stellar mass, the neutral gas component, and various dark matter (DM) models. The stellar mass was adjusted using the mass-to-light ratio, a critical factor in our study. We describe the DM component within the ΛCDM framework, using two distinct profiles: the pseudo-isothermal sphere and Navarro-Frenk-White. With the values for dynamical, stellar, gas, and dark matter mass determined, we derived assorted mass functions and distribution functions for our sample. By adding up all baryonic components we constructed a Baryonic Mass Function (BMF) and compared it to another derived from a larger Galactic volume. In addition, we analyzed the Milky Way's position on the BMF.

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Invited Lecture

THE IMPORTANCE OF INTERACTION STRENGTH FOR NON-MERGER GALAXY ENCOUNTERS (PHD THESIS)

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Galaxy flybys, a class of non-merger interactions, outnumber mergers at lower redshifts (e.g. $z \leq 2$), particularly in higher-density environments. Some of the previous research adopted merger-based classification based on the mass ratio of interacting galaxies, differentiating between equal-mass and lower-mass flybys (i.e. major versus minor). However, cosmological simulations showed that major flybys are extremely rare and almost exclusively distant, while minor ones are much more frequent, with the secondary galaxy penetrating deep into the primary. We demonstrated that this leads to comparable strengths of interaction between the two sub-classes and essentially the same effects. Focusing on morphological consequences, we will showcase a few examples (formation of spirals, bars and some complex structures). Thus, flybys should be classified primarily based on the interaction strength and explored further as they contribute to the structural diversity of galaxies observed in the local Universe.

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Invited Lecture

IDENTIFICATION OF POTENTIAL RED NOVA PROGENITORS

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Luminous red novae are rare transient events thought to be the result of the merger of contact binary system components into a single star. So far, there is only one confirmed observed event, that of V1309 Sco (Nova Sco 2008). Unfortunately, that system was recognized as a contact binary only after the merger event, so targeted observations to fully elucidate the properties of the components and events leading up to the merger itself could not be performed. With ever increasing number of identified contact binary systems from sky surveys there is heightened interest in the identification of red nova progenitors. We have developed and are refining methods and relationships linking geometric parameters obtained through light curve analysis and the mass of the primary component with orbital instability. We discuss s ome theoretical and practical applications of the new relationship to a group of poorly studied c ontact binary systems. In addition, we briefly touch on the effects of stellar composition on contact binary orbital stability.

Invited Lecture

SATELLITE LINES IN THE INTERACTING BINARY V356 SGR'

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Our study presents a spectroscopic analysis of the eclipsing binary V 356 Sgr. We introduce high-resolution spectroscopy and concurrent light curve modelling to this system, addressing parameter discrepancies. Through spectral disentangling, we enhance precision in determining orbital and physical properties. A notable result is the revelation of unique satellite lines in V 356 Sgr's spectrum, previously observed in studies of β Lyrae. We suggest these lines result from disk geometry and shock regions. These regions could arise due to light absorption from the donor star within the system's hot and luminous spots. Additionally, we used the Module for Experiments in Stellar Astrophysics (MESA) code, providing insights into the system's evolutionary status. This investigation deepens our understanding of V 356 Sgr's dynamics and contributes to Algol-type binary knowledge. The fusion of high-resolution spectroscopy, advanced light curve modelling, and MESA-derived evolutionary analysis holds promise for uncovering complexities in binary systems.

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Invited Lecture

MAGNETIC ACTIVITY EFFECTS IN ORBITAL LIGHT CURVES OF BINARY SYSTEMS

Juan Garces Letelier, R. E. Mennickent

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Magnetic activity effects in orbital light curves of binary systems In close binary systems, where at least one of the components shows magnetic activity, it is possible to observe distinctive features in their light curves. Long-term photometric analysis can be used to study the lifetime of stellar spots and their behavior on the stellar surface, for example. Similarly, detailed photometric analysis could reveal more unexpected aspects in the behavior of the orbital light curves, which could also be related to magnetic activity. Recently, we have studied the light curves of Double Periodic Variable-type binary systems and discovered cyclic changes in their orbital light curves. These changes could be explained by structural changes in the accretion disk surrounding the more massive star. This could be due to a magnetic dynamo acting on the donor star. However, testing this hypothesis requires more extensive research. Focusing first on particularly intriguing cases will be crucial for studying magnetic dynamos in rapidly rotating stars and understanding their influence on stellar evolution. Our recent discoveries open up new avenues for unraveling the enigmas of stellar magnetism.

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Progress Report

X-SHOOTING ULLYSES: MASSIVE STARS AT LOW METALLICITY

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Low-metallicity massive stars are essential building blocks of the Universe. They are supposed to be progenitors of certain supernovae, gamma-ray bursts, and compact black-hole mergers. To better understand the low-metallicity Universe which is fundamentally different from our own Galaxy, the Hubble Space Telescope has devoted 500 orbits to observe 250 massive stars at low metallicity in the ultraviolet (UV) in a frame of the ULLYSES program. The complementary "X-Shooting ULLYSES" (XShootU) project provides enhanced legacy value by adding high-quality optical and near-infrared spectra obtained with the X-shooter spectrograph at ESO's Very Large Telescope. We present first results obtained based on combined ULLYSES UV and XShooter optical spectra and their importance for the uniform determination of stellar and wind parameters as a function of metallicity. We also show our predictions of the state-of-the-art theories of stellar evolution combined with those of stellar atmospheres for a certain type of metal-poor (0.02 $Z_{\odot}$) hot massive stars, the chemically homogeneously evolving stars that we call Transparent Wind Ultraviolet INtense (TWUIN) stars.

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Progress Report

MASSIVE STARS AND DIFFUSE EMISSION SOURCES IN THE GALAXY IC 1613

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We present the study of HII regions and massive stars feedback in the local dwarf irregular galaxy IC 1613 with particular attention to search for new supernovae remnants and nebulae related with evolution of massive stars. Previous observations revealed numerous shells of the ionized gas covering the whole extent of the optical galaxy. Also, 8 candidates for Wolf-Rayet stars (WR) were reported previously, whereas only one WR star and one supernova remnant have been confirmed yet. Using 1.5m, 2.5m and 6m telescopes we have obtained the deepest images of IC 1613 to date in the Ha, [SII] and HeII4686 emission lines and optical spectroscopy data for the diffuse shell-like, ionized nebulae located in the giant ($\sim$ 1 kpc) atomic gas supershell. We analyze ionization conditions of these regions in order to link them with the ionizing sources. We report about the faint shell showing no optical source of ionization together with X-ray source inside. We further consider the spectrophotometric properties of four WR star candidates using both our HeII image and archival MUSE/VLT spectra.

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Invited Lecture

RESEARCH OF THE IMPACT OF STRONG SOLAR FLARES: MULTI-INSTRUMENTAL INVESTIGATION

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As an important aspect of space weather (SW) is consequences to intense solar flares (SFs) and coronal mass ejections (CMEs). Short in duration but huge explosive events on the Sun release high-energy particles and intense broad range radiation influencing the SW and producing extreme phenomena. These extreme events was investigated through a multi-instrumental approach, by employing space- and ground-based observations.

Invited Lecture

REDUCTION OF THE VLF SIGNAL NOISE AS POTENTIAL EARTHQUAKE PREKURSOR: PILOT STUDIES

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Reduction of the VLF signal noise as potential earthquake prekursor: pilot studies Studies of pre-earthquake disturbances in the ionosphere since the middle of the last century point to several types of potential precursors to these natural events. A large number of them are detected as disturbances in the Global navigation satellite system (GNSS) and very low / low frequency (VLF/LF) signals a few days before the earthquake. However, the analysis of the VLF signal emitted in Italy and received in Belgrade in the period around the earthquake in Kraljevo that occurred on 3 November, 2010 indicates a potentially new type of these precursors. It is visible as a reduction of the VLF signal noise several minutes to several tens of minutes before the earthquake. In addition, Fourier transform of the recorded data indicates wave excitation at discrete waveperiods under 2 s, and wave attenuation at other waveperiods. In this paper, pilot studies of the noise reduction of the amplitude and phase of the mentioned VLF signal in both time and frequency domains are presented. The data recorded by the Absolute Phase and Amplitude Logger (AbsPAL) receiver located at the Institute of Physics Belgrade on November 3, 4 and 9, 2010, and during the period of intense seismic activity when almost 1000 earthquakes occurred in Central Italy from 25 October to 3 November, 2016, are analyzed. The obtained results indicate possible differences in the signal noise reduction in cases when the observed earthquake follow and not follow previous earthquakes in approximately the same area. Namely, in the first case, the signal noise reduction may already be present so that no new reductions occur before subsequent earthquakes. On the analyzed sample of 35 earthquakes of minimum magnitude 4, the signal noise is reduced in over 90% of cases. In the remaining three cases, it cannot be clearly concluded whether this reduction exists due to its reduced value over a longer time period, which can be explained by the intense seismic activity in that period.

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Progress Report

ELECTRON TRANSPORT AND STREAMER DISCHARGES IN THE ATMOSPHERE OF PRIMORDIAL EARTH

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The seminal experiment of Miller and Urey suggested that electric discharges may have contributed to the origin of life by supplying energy for the activation of molecules and by the formation of amino acids. In this presentation we discuss electron transport and streamer discharges in a strongly reducing gas mixture used by Miler and Urey as well as in a weakly reducing gas mixture suggested more recently by Kasting. A multi term numerical solution of the Boltzmann equation and Monte Carlo simulation technique are used to calculate electron swarm transport coefficients as a function of the reduced electric field. The values of mean energy, drift velocity, diffusion tensor and rate coefficients for ionization and attachment are reported here and compared to those calculated under the conditions of modern Earth. Using a Monte Carlo simulation technique and our latest experimental measurements, we study the role of anisotropic scattering in rotational collisions of electrons with CO molecules. Using a 2.5D particle in the Cell/Monte Carlo code and the fluid equation-based code, we study the inception and propagation of positive and negative streamers in different atmospheres. Our simulation results reveal that streamer discharges in the Miller-Urey mixture incept at lower electric fields than those in the gas mixture suggested by Kasting and partly those on modern Earth. This implies that streamer and lightning discharges into the atmosphere of ancient Earth around 3.8 Ga could have been more difficult to incept than previously thought. The research findings and methodology in this work illustrate how astrobiology and plasma physics interact with each other. The methodology for the study of electric discharges and transient plasmas, which is presented in this work, can be generalized and extended for the study of the atmospheres of exoplanets.

Progress Report

WE CAN SPREAD OUR GENETIC MATERIAL

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Despite our inability to send humans to the stars we still can send our Earth genetic material toward them, with small chance it will reach exoplanets around them. Our chance is embedding interstellar objects (ISO) which constantly trespass our Solar system with samples of organisms which can withstand long cry-preservation. New researches in biology return promising results. If the number density estimates based on the discovery of two ISOs are even approximately correct, there should be a number of ISO in the solar system at any one time. Future sky surveys should start finding a regular stream of 1I-type ISOs. 2I-type interstellar comets appear to be much rarer, and will probably be a decadal phenomena. Intermediate, sub-km sized, ISOs, which could be either asteroidal or cometary in nature, should exist, and should plausibly have an intermediate infall-rate between 1I and 2I-type objects. They are also good targets for our aim to dispersed genetic material. For decades to come, ISOs will be fundamentally easier to explore than nearby stellar system. A long term program to find and visit ISOs can start now with existing technology. Recently it is demonstrated that a mission to 1I/'Oumuamua would be feasible, even without Solar Oberth Maneuver, and could be used to explore ISOs. New technology and new instruments will be required to best find passing ISOs, and also crucial development of technology for safely embedding of genetic samples inside ISO to best utilize the opportunities that ISOs provide.

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Progress Report

RESULTS FROM SOLAR WEATHER RESEARCH AT LOW-BACKGROUND LABORATORY FOR NUCLEAR PHYSICS

Nikola Veselinović

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Cosmic rays, originated from outside of the Solar system are sensitive to properties of interplanetary medium and violent energetic events originated from the Sun that can additionally modulate CRs. Connection between energetic particles flux measured in-situ at L1, measured ground level cosmic ray muons' flux during associated Interplanetary coronal mass ejections is examined at Low-background laboratory. It is shown that a combination of data from ground and space-based sources can lead to improvement of the analysis of violent energetic events on the Sun and how the Sun affects space weather. Investigation on influence of CR flux on Earth environment is also discussed, particularly production of cosmogenic radionuclides in soil (loess) but also recent measurements of low radiation activities of meteorites done in Low-background laboratory. Laboratory is a part of an emerging worldwide network of low-cost, modular ground muon detectors with the main goal to study space and terrestrial weather. Our involvement with this endeavor will be presented and it will further enhance our capacity building activities in the field of space weather applications.

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Progress Report

DISSECTING THE ACTIVE GALACTIC NUCLEUS IN CIRCINUS GALAXY

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Circinus galaxy harbors an archetypal obscured active galactic nucleus (AGN). At a distance of ~ 4 Mpc, it is one of the closest Seyfert 2 galaxies, allowing high angular resolution studies across a wide range of wavelengths. Recent MIR interferometry and single dish imaging have cast this galaxy in a major role as a prototype of the newly recognized population of polar dust AGN. In this picture, a major fraction of the MIR emission is associated with dusty winds blown away from the sublimation zone by radiation pressure. I will present our recent and ongoing efforts to understand the obscuring and outflowing structures in Circinus using MIR imaging and interferometry, optical polarimetry and X- ray observations, tied together by state-of-the-art radiative transfer simulations. All the evidence paint a consistent picture of a compact dusty disk responsible for the obscuration and feeding of the black hole, and a dusty outflow in the polar direction, illuminated by tilted accretion disk.

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Progress Report

ACCELERATING MCRT SIMULATIONS USING DIMENSIONALITY REDUCTION TECHNIQUES AND INLA

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We propose a novel post-processing technique to enhance the output of Monte Carlo Radiative Transfer (MCRT) simulations. Our approach involves combining dimensionality reduction techniques, namely Principal Component Analysis (PCA) and Non-negative Matrix Factorization (NMF), with Gaussian Markov random fields and the Integrated Nested Laplace Approximation (INLA) to reconstruct noisy or missing data. To evaluate the effectiveness of our methodology, we use synthetic observations of a galaxy from the SKIRT Auriga project. Using computationally less expensive, lower-quality images as input, our post-processing technique is able to reproduce high photon number reference images approximately 5 times faster, with median residuals below 20%.

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Progress Report

A NEW ERA OF EXOPLANETARY MODELLING COMMENCED BY FIRST JWST OBSERVATIONS

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I will present the complete public findings about to the latest groundbreaking discoveries related to the exoplanetary atmospheres, which were made possible by the recently launched James Webb Space Telescope (JWST). In anticipation of the influx of outstanding exoplanetary data that will be observed with unparalleled precision, resolution, and wavelength coverage in the next 10 years of the planned JWST mission, during the initial five months of JWST science operations we observed three compelling and representative exoplanet targets possessing exceptional scientific merit. Utilizing four JWST instruments, we employed three transiting planet characterization geometries (transits, eclipses , and phase curves), and covered a wavelength range of 0.6 to 12 microns, perfect for uncovering planetary temperatures, compositions, chemical processes, clouds, and climate. Our objective was to inform the scientific community about the sensitivity of each JWST instrument, comprehend their scientific capabilities, elucidate the plausibility of ambitious precision objectives, and direct future observations. These first outcomes went beyond the scientific returns of any prior space or ground-based instruments and produced 7 Nature papers, revealing observations with almost no systematic errors and setting limits on yet-undetected chemical species and processes in exoplanetary atmospheres. Some of these species signify JWST's ability to detect molecules expected to be present on smaller, cooler, rocky planets, providing insight into the composition, formation, and evolution of Earth-like planets. This prompts the question: what comes next, and are we entering a new era of exoplanet characterization?

Invited Lecture

MULTI-WAVELENGTH VARIABILITY AND QUASI PERIODIC OSCILLATIONS (QPOS) IN BLAZARS

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This is the age of multi-wavelength (MW) time domain astronomy in which the transient astronomical sources are of great interest due to their rapid change in flux, spectrum and polarization. Simultaneous MW observation of a particular transient source over an extended period of time has importance to understand the emission mechanism in different electromagnetic (EM) bands. Blazar is a subclass of active galactic nuclei (AGN), and among one of the most favorite astronomical transient objects, because they emit radiation in the complete EM spectrum, and their flux, spectrum and polarization are highly variable. In the present colloquium, I will present some of the key results of blazars we have obtained in single EM band, simultaneous MW, and also detected QPOs in the time series data.

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Progress Report

HISTORIES OF GALAXIES IN THE MIDDLE-AGED UNIVERSE

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The assembly trajectories of galaxies are imprinted in their spectroscopic and morphological properties. Large mass-limited samples of quiescent galaxies with available spectroscopic signatures and high quality imaging in the rest-frame visible regime are uniquely suited for studying galaxy archaeology. We model stacked spectra of 100,0000 galaxies in the HectoMAP survey to estimate ages and metallicities and to reconstruct star formation histories of quiescent systems at $0.2 < z < 0.6$. We further combine these results with the measurements of galaxy structural and environmental properties. I will demonstrate how our analysis has enabled us to separate and quantify the effects of internal and external processes on the average galaxy size and mass growth over 10 billion years of cosmic time.

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Invited Lecture

PROPERTIES OF THE TIDAL SUBSTRUCTURES IN THE ANDROMEDA GALAXY (PHD THESIS)

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We investigate the properties of the Giant Stellar Stream (GSS), formed in the merger of Andromeda galaxy (M31) and dwarf galaxy, the satellite of M31. We used N-body simulations to explain the properties of tidal substructures. The orientation of the GSS, distances, and velocities from our simulation are in agreement with the observed one. We confirmed that the Northeast shelf (NE) and West shelf (W) are formed in the same merger event. For the first time, we explained the observed metallicity distribution in the GSS and shell system. With a linearly decreasing gradient of the initial metallicity in the dwarf galaxy before the merger, using Monte Carlo (MC) simulations, we successfully explained the observed metallicity distribution in these substructures. These results are a contribution to the investigation of metallicity gradients in dwarf galaxies which is important for galaxy evolution in general.

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Progress Report

FAST NUMERICAL TEST OF INFLATIONARY MODELS

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According to the inflation theory, the cosmos experienced an extremely fast expansion in its early stages. Although inflationary cosmology has successfully supplemented the Standard Cosmological Model, little is understood about the inflationary process in general, and its beginning in particular. Calculating the values of the observable parameters, namely the scalar spectral index (n_s) and the tensor-to-scalar ratio (r), and confronting them with the Planck collaboration's observational findings is the most important approach to verify inflationary cosmology models. This talk will review the numerical approach and tools we created for quickly evaluating various inflationary models. The calculation in the software starts with finding the numerical solutions of the Friedman equation and equations of motion. The obtained solutions are utilized to determine the observational parameters n_s and r and the Hubble slow-roll parameters ($\uparrow \mu_1, \uparrow \mu_2, \uparrow \mu_3, \uparrow \mu_4$). We compare the results of Monte Carlo simulations for different inflationary models obtained based on analytical calculations of observational parameters for individual models with the results obtained based on universal approximate expressions for observational parameters. We will analyze the statistical difference between the results obtained in these two ways and test the possibility of using universal approximate expressions for the calculated values of observation parameters. The simulated values of the observational parameters will also be compared with the results of the Planck mission.

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Progress Report

DEEP IMAGING WITH MILANKOVIĆ TELESCOPE: LINKING MERGER HISTORY TO KINEMATICS OF ELLIPTICAL GALAXIES

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Kinematical and morphological features observed in early-type galaxies (ETGs) carry valuable information on the evolution of their hosts. We studied the origin of prolate rotation (i.e. rotation around the long axis) in Illustris large-scale cosmological hydrodynamical simulations. We found that basically all the simulated massive prolate rotators were created in relatively recent major mergers of galaxies. Such mergers are expected to produce tidal features (tails, shells, asymmetric stellar halos). We investigated deep optical images of prolate rotators, including newly obtained Milanković data, and found signs of galaxy interaction in all of them, which proves to be a statistically very significant correlation when compared with a general sample of ETGs in MATLAS — a deep imaging survey. In an ongoing project, we use Milanković to assemble deep images of the complete sample of all known nearby massive prolate rotators. In addition, we searched these data for asteroids to improve the accuracy of trajectories and even found one previously unknown asteroid. The most frequent tidal features among the prolate rotators happen to be shells. We developed methods to calculate the probable time of the merger from optical images. This will allow us to compare the merger history of the sample with predictions from Illustris. In our current project of Marie Skłodowska-Curie Actions, we plan to expand the methods to use them on even larger samples of shell galaxies supplied by upcoming large surveys like LSST at Rubin Observatory. This will provide an unprecedented amount of statistically significant data on the recent merger history of our Universe and allow extensive investigation of impact of mergers to a wide range of other astrophysical phenomena.

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Progress Report

SPECTROPOLARIMETRIC INVERSIONS USING CONVOLUTIONAL NEURAL NETWORKS

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Modern observations of the solar atmosphere provide us with spatio-spectral information of very high resolution. This allows us to study the solar atmosphere in all three dimensions in great detail, but makes the problem of quantitative interpretation very difficult from the computational point of view. The vast amounts of data obtained by state-of-the-art solar telescopes make conventional methods borderline unfeasible. To this end, multiple approaches based on machine learning and specifically neural networks have been suggested. In this contribution we will briefly review existing approaches and focus on our take on this problem: "mimicking" spectropolarimetric inversions by means of convolutional neural networks. We show that by using supervised learning, based on the results of conventional approaches, we can obtain a speed-up of several orders of magnitude by retaining the quality of the fit and increasing the spatial coherence of the result.

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Progress Report

LARGEST ASTRONOMICAL OPTICAL TELESCOPES

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We present a review of the largest astronomical optical telescopes which are presently operational or under construction. Their scientific goals are discussed briefly, particularly with respect to astrophysical spectroscopy and interferometry.

Progress Report

DEVELOPMENT OF A MULTIFUNCTIONAL INSTRUMENT FOR THE 1.4m MILANKOVIĆ TELESCOPE

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In this work, we would present the idea and plan for the construction of a multifunctional device that is planned for the 1.4m Milanković telescope at the Astronomical Station Vidojevica. The device would be optimized to operate in three modes - low resolution spectroscopy, photo-polarization and imaging. We are working on the project in cooperation with the SAO RAS observatory, which has a long history in designing and building similar instruments. We will present the main idea of the project, conceptual projects that we have considered so far with colleagues from SAO RAS observatory, and the possible technical solution of the device that is optimal for the Milanković telescope with reference to scientific projects that could be done on that device.

Progress Report

KINEMATICS OF TYPE II CEPHEID PULSATING STARS

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In the GAIA Data Release 3 catalogue, published in 2023, there are 15021 stars classified as Cepheids. We will use a subsample of stars classified as Type II Cepheids (T2C) from the GAIA catalogue that have all the necessary parameters (full astrometry and radial velocity) to calculate the galactocentric orbits of these stars. For this we will use the analytical potential proposed earlier by one of the authors. We will calculate angular momentum and energy of the stars to determine if they belong to some of the know mergers, as it has been shown that satellites galaxies of the Milky Way can be considered as particles with very similar integrals of motion. We will analyse the distribution of the energy and angular momentum for our sample of stars. It is very likely that most of the T2Cs were created in the Milky Way, there is a subgroup of T2Cs that have significantly different metallicities than the other stars. This could be an indication that they might have originated from differe nt surroundings, such as a different galaxy, and came to the Milky Way via a merger event. In this work we will examine this possibility.

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Progress Report

DYNAMICS OF SPIRAL GALAXIES IN NONLINEAR REGIME

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The baryonic mass of galaxies is the sum of both stars and gas: a great deal is known about stars. Atomic gas typically dominates the mass of non-stellar material in disk galaxies. Its mass follows directly from the distance to each galaxy, the measured 21 cm flux, and the physics of the spin flip transition of hydrogen. Late type, low surface brightness disk galaxies usually have gas masses in excess of their stellar masses, so that the nonlinear approach of mass distribution for the gas component could be of crucial interest. There is growing evidence for the appearance of spiral arms in BLRs with a characteristic radius overlapping that of self-gravitating regions of accretion disks. These features can be detected with high-quality RM and differential interferometric observations via such instruments as GRAVITY on board the Very Large Telescope Interferometer (VLTI). Both scales, galactic disk and accretion disk, can be treated by implementation of NLS equation for the gas component which includes temperature gradient of the considered region.

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Progress Report

ON THE STARK BROADENING OF SPECTRAL LINES OF HIGHLY IONIZED IRON FOR THE INVESTIGATION OF NEUTRON STARS

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When in a stellar atmosphere temperature is higher from around 10 000 K, the hydrogen is mainly ionized and broadening of spectral lines by collisions with charged particles or Stark broadening becomes main pressure broadening mechanism. Data on this broadening are significant for determination of many important astrophysical quantities as for example modelling of stellar plasma, analysis and synthesis of spectral lines, the calculations of absorption coefficient, opacity, radiative transfer, abundance determination, acceleration of gravity etc. In the case of neutron stars, Stark broadening is very important. A part of them has a tiny atmosphere of highly ionized iron. So, data for Stark broadening of Fe XXV and Fe XXVI are needed, since usually their values are calculated very approximately. On the other hand such data are also of interest for proton-boron fusion experiments, so that we included and collisions with B VI ions. Stark broadening parameters, full widths at half intensity maximum and shifts (determining Lorentzian line profile) for important spectral lines of Fe XXV and Fe XXVI broadened by electron-, proton- B VI- and Fe XXVII ions-impacts, have been calculated with the help of the semiclassical perturbation formalism, for plasma conditions of interest for neutron star atmospheres and their environment, as well as for proton-boron fusion experiments. Examples of obtained results and the corresponding discussion are presented.

Invited Lecture

INVESTIGATION OF ACTIVE GALACTIC NUCLEI IN THE LEGACY SURVEY OF SPACE AND TIME (LSST)

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Vera C. Rubin Observatory is an advanced astronomical facility in Chile dedicated to conduct a ten-year survey of the Southern sky - the Legacy Survey of Space and Time (LSST). The LSST aims to provide answers to some of the biggest questions about the Universe, from the Solar System to Cosmology. Within, it will allow studies of the tens of millions active galactic nuclei (AGNs) on massive scales in both special and time-domain. Here we briefly describe the facility and the LSST survey, and focus on the activities in the preparation for the AGN science. Moreover, we will present activities of the Serbian AGN Group (SER-SAG) and its contribution to the LSST.

Progress Report

EVIDENCE OF POSITIVE AGN FEEDBACK IN THE GREEN VALLEY

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Green valley galaxies showed to be very important for understanding the quenching of star formation, the morphological transformation of galaxies from late- to early-types, and the evolution of galaxies across cosmic time. Most of the AGN detected in X-rays and optical have been found in the green valley, suggesting that AGN may be responsible for quenching star formation in galaxies. However, this picture seems to become more complex when we use multi-wavelength data, such as in the far-infrared, where several studies suggest indications of positive AGN feedback on star formation. This talk will provide an overview of the most recent studies on green valley galaxies and the role that AGN may play in the morphological transformation of galaxies and galaxy evolution, from both optical and multi-wavelength perspectives.

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Progress Report

MUSE-NFM OBSERVATIONS OF THE CIRCINUS ACTIVE GALACTIC NUCLEUS

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We present integral-field spectroscopic observations of the Circinus galaxy performed with the MUSE narrow field mode on the VLT. The spatial resolution of $\sim 0\farcs1$ within the field-of-view of $7\farcs5 \times 7\farcs5$ enabled us to zoom into the ionized gas kinematics within the central 100pc of the AGN. The analysis revealed that the systemic component resembles the ionization cone structure seen in larger scales, while the outflowing component shows a "tuning-fork" morphology: a collimated structure originating ~ 8 pc from the AGN location and extending in the north-western direction before it splits into two arms at around 30pc from the AGN. We speculate that the origin of the collimated outflow might be due to the radio jet and ISM interactions on parsec scales, while a presence of a dust clump at the tip of the collimated part of the outflow might explain its fragmentation. The estimated total instantaneous and time-average mass outflow rates suggest that the observed outflow is not expected to regulate star formation within the ~ 100 pc. BPT diagram revealed that the dominant source of ionization is the AGN. In addition, we will also present the morphology and kinematics of the coronal gas traced by the high-ionization forbidden lines.

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Progress Report

THE INFLUENCE OF INTERACTIONS OF DISTANT GALAXIES ON THEIR NON-THERMAL RADIO EMISSION

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It has been established that a strong linear correlation exists between the thermal far-infrared (FIR) and non-thermal radio emissions of star-forming galaxies. Recent research on this correlation at high redshifts has revealed that it is evolving as redshifts increase. This paper explores potential physical factors contributing to this correlation's evolution, with one likely explanation being galaxy interactions. Galaxie's morphology serves as an indicator of past or ongoing interactions, as irregular galaxy shapes are often the result of collisions or close encounters. To investigate this hypothesis, a sample of dusty star-forming galaxies from the COSMOS field, up to a redshift of z = 3.5, was carefully selected. The sample was divided into two subsets based on morphological types: disk and irregular galaxies. The evolution of the correlation with redshift was analyzed separately for each subset. The study did not find any indication of redshift evolution in the FIR-radio correlation for both disk and irregular galaxy subsets. However, the analysis did reveal that irregular galaxies exhibited a lower mean correlation parameter, qFIR, suggesting that they might influence the correlation's evolution if their prevalence in the sample increases at higher redshifts.

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Progress Report

DUSTY WINDS IN ACTIVE GALACTIC NUCLEI (MASTER THESIS)

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According to the standard model of active galactic nuclei (AGNs), the accretion disk and gas clouds around the black hole are enveloped by the so-called "dusty torus". However, recent observations with the state-of-the-art instruments in the infrared domain have indicated that large amounts of dust are being ejected in the form of the "dusty winds". By comparing observations of the nearby active galaxy Circinus with the results of numerical radiative transfer simulations, a prototype model of these dusty winds was established. In the next phase of research, it is necessary to apply the model to a larger sample of AGNs. As part of this master's thesis, an extensive library of models was calculated for different values of the parameters that describe the dusty winds. For this purpose, we used the SKIRT code, which enables simulating the radiation transfer through dust. We measured certain properties of the obtained spectral energy distributions of the model (e.g. spectral indices, width and strength of the silicate emission), and compared them with the observed values. We analyzed the distribution of the values of these characteristics depending on the model parameters. The results of this thesis and the calculated library of models represent the starting point for further research of the structure and properties of the dusty winds in AGNs, and interpretation of observations from the James Webb Space Telescope.

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Invited Lecture

INTERSTELLAR INTERLOPERS AND DARK COMETS

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In recent years, two entirely new classes of planetesimals have been discovered in the solar system: interstellar interlopers and dark comets. These still-enigmatic objects are challenging our understanding of the behavior and properties of comets and asteroids. In this talk, I will review what has been learned to date from the known interstellar objects and dark comets, highlighting the attributes that are difficult to reconcile with previous models of planetesimal behavior. I will present recent hypotheses that can explain their unusual behavior through natural mechanisms, including the acceleration of 1I/'Oumuamua via release of radiolytically produced and entrapped molecular hydrogen. One of the dark comet candidates, 1998 KY26, is already the target for the extended Hayabusa2 mission and exhibits favorable viewing geometry before 2025. The forthcoming Rubin Observatory Legacy Survey of Space and Time (LSST) is poised to further transform our understanding of these classes of objects, and I will discuss the feasibility of future discoveries via ground-based observations as well as possible intercept missions. Finally, I will discuss existing and potential collaborations with Serbian astronomers.

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Progress Report

ORBITAL STRUCTURE OF INTERSTELLAR OBJECTS IN THE SOLAR SYSTEM

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The discovery of the first two interstellar objects (ISOs) passing through the Solar System has opened entirely new perspectives in planetary science. Exploring these objects provides qualitatively novel insights into the processes related to the origin, structure, and evolution of planetary systems across the Galaxy. Knowledge about the ISO population and associated phenomena would significantly advance with the discovery of new objects. On the other hand, adjusting algorithms for their discovery through ongoing and upcoming sky surveys greatly relies on the ability to assume their orbital structure. A method for generating synthetic orbits of interstellar objects in the solar system will be presented, as well as the dependence of the orbital structure of this population on their kinematics in interstellar space.

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Progress Report

ANALYSIS OF THE 77899 (2001 TS117) ASTEROID FAMILY

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We report here a discovery of the 77899 (2001 TS117) asteroid family. The newly discovered group possesses some unique properties that make it especially interesting to study. In particular, the family is located in the outer main belt, beyond 3 au, but consists of S-type rocky asteroids, which are rare in this portion of the belt. The family is close to the 2/1 MMR with Jupiter and, possibly more importantly, to the nu6 secular resonance with Saturn. The latter resonance is known to be the main transport route of asteroids from the main belt to the near-Earth region. In this work, we estimated the age of the family and modelled its long-term dynamical evolution. Based on this, we constr ained several family-related parameters, including the flux rate towards the near-Earth region and the collisional probability of family members with the inner planets.

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Progress Report

CONFIDENCE REGION FOR ORBITAL ELEMENTS OF VISUAL BINARIES

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Studying the orbital dynamics of visually binary stars plays a crucial role in understanding celestial systems and their evolution. Accurate determination of the orbital elements of these systems is essential for characterizing their physical properties and predicting their future behavior. However, due to various observational and measurement uncertainties, obtaining precise estimates of these orbital elements is a challenging task. We present a novel approach for constructing confidence regions for the orbital elements of visually binary stars. By considering the uncertainties associated with observations, including measurement errors and astrometric accuracy, we propose a statistical framework that quantifies the confidence in the estimated values of the orbital parameters.

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Progress Report

VERTICAL STRUCTURE OF DEBRIS DISCS AND COLLISIONAL DAMPING

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Many main-sequence stars are found to be surrounded by discs or belts of planetesimals and dust. In the Solar system, these belts are the main asteroid belt and the Kuiper belt. For some of the extrasolar planetesimal belts which are observed edge-on, high-resolution imaging allows to constrain their vertical scale-height. The scale-heights are indicative of the dispersion in particle inclinations, which itself is directly related to the dynamical state of the belt. We perform a numerical study of collisional evolution of a planetesimal belt in a phase space of mass, pericentre distance, eccentricity and inclination, with particle sizes ranging from km-sized planetesimals down to micron-sized dus t. We study evolution of the disc vertical structure due to the effect of collisional damping and how the scale-height varies for particles of different sizes. We discuss our theoretical predictions in the context of previous analytic and numerical work, and relate them to observations of edge-on discs.

Invited Lecture

NEW DEVELOPMENTS IN SHOCK ACCELERATION

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I present some recent developments in the theory of shock acceleration that stemmed out of hybrid (kinetic ions/fluid electrons) kinetic simulations. In particular, I discuss how the choice of the electron equation of state may affect the overall shock dynamics and the spectra of accelerated particles. I also discuss the importance of the simulation dimensionality, outlining a novel channel of rapid acceleration at oblique, weakly magnetized shocks. I finally discuss the role of accelerated particles in accounting for the phenomenology of SN1006.

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Progress Report

NON-LINEAR EVOLUTION OF SLAMS TURBULENCE AND ITS ROLE IN PARTICLE ACCELERATION AT ASTROPHYSICAL SHOCKS

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The cosmic-ray (CR) driven waves in the upstream of collisionless high-Mach number shocks can propagate with a super-alfvenic velocity, which leads to the growth of nonlinearities such as short large amplitude magnetic structures (SLAMS). The SLAMS which were previously observed at the Earth bow shock, are found to be much more prominent at higher Mach number shocks associated with the most energetic events such as supernovae, novae, active galactic nuclei, pulsars, and galaxy mergers. We present the results of test particle and particle-in-cell simulations, which show how such structures trigger a quasi-per iodic formation of new shock fronts ahead of the current shock, and how they interact on large scales throughout their evolution. Once SLAMS develop in the upstream of astrophysical shocks, electron injection and acceleration become entirely shaped by these non-linear structures. The induced anomalous diffusion results in new forms of particle acceleration, which can lead to breaks and steeper slopes in the source spectra of CR electrons.

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Progress Report

INTERSTELLAR DUST FLUX VARIATION NEAR 1 AU: INSIGHTS FROM STEREO/WAVES AND WIND/WAVES INSTRUMENTS

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In-situ observations with radio instruments allow the study of dust grains from various sources. The impact of these grains on the spacecraft generates distinct voltage waveforms. Among the dust populations at 1 AU, interplanetary and interstellar dust (ISD) are the most important. The ISD moves at about 26 km/s relative to the Sun, reflecting the velocity of the solar system in the interstellar medium. Considering the spacecraft's orbital motion with respect to the direction of ISD flux, we can distinguish ISD from other dust populations in the solar system. Our analysis focuses on dust events recorded by the STEREO /WAVES r adio instrument, covering the period from 2007 to 2021 for STEREO A and from 2007 to 2015 for STEREO B. In addition, events recorded by the Wind/ WAVES electric field instrument from the beginning of the mission through 2021 were examined. This multi-spacecraft approach allows long-term monitoring of the ISD flux at 1 AU. During the period from 2007 to 2012, which was characterized by a solar minimum with the solar dipole pointing south, all three spacecraft recorded the ISD flux at 1 AU. However, before and after this period, a disappearance of the ISD component is observed. This observation suggests a variation in the observed ISD flux with respect to the solar cycle. The change in polarity of the magnetic dipole field during the solar cycle causes small interstellar grains to experience focusing or defocusing effects. Consequently, dust grains are systematically deflected toward or away from the solar magnetic equatorial plane by the solar wind magnetic field. These dynamics have a direct impact on the overall behavior of the dust and the overall ISD flux in the inner heliosphere.

Invited Lecture

ABOUT SOME NEAR-EARTH ORBITS

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The population of near-Earth objects currently counts more than 30000 known members. In general, NEOs have chaotic orbits (due to numerous resonances with planets and proximity of the Moon), short lifetimes (in terms of Solar system timescales), and often short predictability of their future orbital evolution. This talk will give some new insights into the dynamical geography of the NEO region, which are obtained with sophisticated numerical tools and a careful selection of orbital parameters. In the second part, we will use such methodology to recover the possible dynamical origins of three near-Earth Apollo asteroids: 3200 Phaethon, 2005 UD and 1999 YC.

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Progress Report

A MACHINE-LEARNING APPROACH TO THE PROBLEM OF IDENTIFICATION ASTEROIDS IN MEAN-MOTION RESONANCES AND ASTEROID FAMILIES

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The classical approach to massive identification of asteroids trapped in mean-motion resonances or belonging to asteroid families require significant computational time and sometimes require human intervention to determine the final status of an object. Conversely, contemporary machine-learning techniques, founded upon supervised learning and neural network algorithms, are capable of executing equivalent tasks with greater efficiency, while concurrently preserving an acceptable degree of accuracy and precision. This work demonstrates how one can perform such studies, train ones models, and use them to identify the status of a set of objects.

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Progress Report

TEN YEARS OF MONITORING OF 1722+119 AT ASV

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We observed 47 sources which are suggested for the link between Gaia CRF and ICRF. The monitoring is performed using telescopes which are located at Astronomical station Vidojevica, from 2013 until 2023. The observations were performed mostly in V and R bands, and occasionally in B and I bands. The statistical tests show that the source is variable. The brightness changed by about 2 magnitudes. We will present the spectral energy distribution, results of analysis of brightness, colour, and spectral index variability for 10 years of observations of source 1722+119.

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Progress Report

THE EQUATION BETWEEN 3-BODY MEAN MOTION RESONANCES AND YARKOVSKY DRIFT SPEEDS ON ECCENTRICITIES HIGHER THAN 0.1

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We studied the motion of asteroids across the 3-body mean motion resonances (MMRs) with Jupiter and Saturn and with the Yarkovsky drift speed in the semimajor axis of the asteroids. The research was conducted using numerical integrations performed using the Orbit9 integrator with 72,000 test asteroids. We calculated time delays, dtr, caused by the six 3-body MMRs on the mobility of test asteroids with 10 positive and 10 negative Yarkovsky drift speeds, which are reliable for Main Belt asteroids. Our final results considered only test asteroids that successfully crossed over the MMRs without close approaches to the planets. We devised equations that approximately describe the functional relation between the average time $\langle \mathrm{d}tr \rangle$ spent in the resonance, the strength of the resonance SR, and the semimajor axis drift speed $\mathrm{d}a/\mathrm{d}t$ (positive and negative) with the orbital eccentricities of asteroids in the range (0.1, 0.2). Comparing the values of $\langle \mathrm{d}tr \rangle$ obtained from the numerical integrations and from the derived functional relations, we analysed average values of $\langle \mathrm{d}tr \rangle$ in all 3-body MMRs for every $\mathrm{d}a/\mathrm{d}t$. The main conclusion is that the analytical and numerical estimates of the average time $\langle \mathrm{d}tr \rangle$ are in very good agreement, for both positive and negative $\mathrm{d}a/\mathrm{d}t$. Finally, this study shows that the functional relation we obtain for 3-body MMRs for orbital eccentricities of asteroids in the range (0.1, 0.2) is analogous to that previously obtained for orbital eccentricities of asteroids in the range (0, 0.1) in Milic Žitnik (2021).

References

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Progress Report

ASTRONOMY EDUCATION IN SERBIA 2020-2023

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Within this contribution we aim to present a review of triennial activities in astronomy education in Serbia at all levels. Starting from the astronomy education at the universities in Serbia, especially the activities of the University of Belgrade - Faculty of Mathematics Department of Astronomy, over the education within secondary schools, to the activities of the Society of Astronomers of Serbia in astronomy education, such as the teachers trainings, organized by the IAU NAEC Serbia.

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Progress Report

THE LIFE AND WORK OF ELIA MILLOSEVICH (1848-1919)

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In this contribution we briefly present the biography and professional activities of the Italian astronomer Elia Millosevich, professor of nautical astronomy at the Royal Institute of the Merchant Navy in Venice and later the director of the Roman College Observatory, whose family originates from the town of Dobrota in Boka Kotorska, present-day Montenegro.

Progress Report

SCIENTIFIC WORK OF WENCESLAS S. JARDETZKY AND COLLABORATION WITH MILUTIN MILANKOVIĆ

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Wenceslas S. Jardetzky (Odesa, 1896 - Elkins, USA, 1962) after graduation worked for a short time at the Observatory in Odessa and the Pulkovo Observatory in Petrograd. When he moved to Belgrade in 1920, he got a job as an assistant at the Astronomical and Meteorological Observatory. Later, he continued his university career at the University of Belgrade, and universities in Austria and the United States of America. The main fields of Jardetzky's research were hydromechanics, astrophysics, geophysics and rational mechanics, in which he published significant scientific works and monographs. Some of his works were inspired by Milanković's theory of climate change and the results presented in his "Canon". Since his arrival in Belgrade, Wenceslas S. Jardetzky has had a fruitful scientific collaboration with Milutin Milanković (Dalj, 1879 - Belgrade, 1958). Milanković was on his committee during the defense of his doctorate, and then the collaboration continued during Milanković's most fruitful period, as evidenced by Milanković's correspondence with colleagues from abroad, where he calls Jardetzky a "faithful collaborator." During Jardetzky's stay in Yugoslavia, Austria and the USA, these two scientists corresponded regularly, and the letters are kept in the SANU archives in Belgrade.

Progress Report

ASTRONOMY EDUCATION THROUGH DIGITAL MEDIA

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In order to bring astronomical content to pupils all across Serbia, which is not part of regular school curricula, and to increase their interest in astronomy, we organized an astrophotography competition called "Take a Photo of the night sky". The competition was intended for primary and high school pupils, whom we invited to submit one photo taken with a mobile device in teams of no more than 5 pupils, under the supervision of a teacher. As part of the competition, professional training was organized for registered teams on how to make successful astrophotography using a mobile device (phone or tablet). A total of 184 teams from all over Serbia participated in the astrophotography competition, including more than 1,400 pupils and 200 teachers from all over the country. The astrophotography competition was organized by NAEC Team Serbia (National Astronomy Education Committee at the International Astronomical Union). Four of the most important astronomical institutions in Serbia were behind the competition: the Society of Astronomers of Serbia, the University of Belgrade - Faculty of Mathematics, the Astronomical Observatory in Belgrade, the Mathematical Institute of the Serbian Academy of Sciences and Arts, and the research and development center United Cloud and EPSON Serbia as partners from the private sector.

Progress Report

NEW EVENTS IN THE ASTRONOMICAL SOCIETY "RUĐER BOŠKOVIĆ"

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Astronomical society "Ruđer Bošković" is the oldest society in the territory of the former Yugoslavia, whose main goal is the popularization of astronomy. Since its foundation, it has relied on input from enthusiasts as well as professional astronomers. The merits of the Belgrade Astronomical Observatory and its employees for the work of the society are immeasurable from the foundation of the society until the present day. Of particular importance is the society's magazine "Vasiona", which over several decades informs the general public about news in astronomy, as well as about events in society. In addition to the improvement of the workspace of the National Observatory and the Planetarium, a complete reconstruction of the Zeiss refractor, as well as other astronomical instruments and objects significant for the history of the society, was recently carried out. New observational methods were introduced, such as CCD astrophotography, spectrometry and photometry. Computer capabilities for processing observations have been improved, access to star catalogs has been made possible, and in the near future the process of automating the operation of the telescope will be completed. The first results of observation, some of which have been published, also came from these methods. Vasiona magazine has continued to be published after a significant break, and educational courses and thematic gatherings are going on smoothly. In the coming period, the improvement of spatial and working conditions will be continued, as well as the preservation of cooperation with professional astronomers and motivated individuals with the aim of sustainable progress and preservation of the achievements of society.

Progress Report

SERBIA IN ASTRONOMICAL CONTESTS BETWEEN 2020-2023

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A review concerning the astronomical contests dealt with by the Society of Astronomers of Serbia, in particular its body National Astronomical Olympiad Committee (NAOC), in Serbia and abroad for the period 2020-2023 is presented. Since in Serbian secondary schools astronomy is taught quite insufficiently, NAOC all that time has organized extra teaching for interested pupils and publishing the necessary literature, mainly by translating into Serbian the existing collections of problems.

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Progress Report

DEPARTMENT OF ASTRONOMY AT PETNICA SCIENCE CENTER: 2021-2023

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The main topic of our review will be the activities held by the Astronomy Department at the Petnica Science Center (PSC) from 2021 to 2023. The focus of the Astronomy Department has been on high school students as participants and the programs created for them. During the whole of the educational cycle at the Astronomy Department, conceived as a two-year program, participants are introduced to the fundamentals of astronomy and its research methodology in the first year, which ultimately leads to the completion of their first research projects by the end of the second year. Therefore, in this review, we will present the current structure of the Astronomy Department at PSC, the topics of the participants' research projects, some of the other activities carried out during the mentioned period, and the outline of our plans for the future.

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Progress Report

PROJECT OF FIRST URBAN ASTRONOMICAL OBSERVATORY IN KRUŠEVAC

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Since 2010, the astronomical society "Eureka" has been actively working on the promotion of astronomy in Kruševac and Serbia. It carries out numerous activities, among which, in addition to citizen science projects and lectures, are astronomical observations. In 2022, the society managed to realize the most important project since its existence, which is the construction of the "Šarengrad" astronomical observatory in the area of the "Šarengrad" amusement park. A year of work has passed since its opening, which is an excellent opportunity for analysis and further improvement of work. In this paper, the results of the association's work in the past year in the field of citizen science, promotion of astronomy will be briefly presented, and the course and implementation of the project to build the first urban astronomical observatory in Kruševac will be presented.

Poster

LOFAR-BG - DEVELOPMENT AND CURRENT STATE

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LOFAR (LOw Frequency ARray) is the largest radio telescope operating at the lowest frequencies that can be observed from Earth. LOFAR makes observations in the 10 MHz to 240 MHz frequency range with two types of antennas: Low Band Antenna (LBA) and High Band Antenna (HBA), optimized for 10-80 MHz and 120-240 MHz respectively. The electric signals from the LOFAR stations are digitized, transported to a central digital processor, and combined in software in order to map the sky. Now there are LOFAR stations in the Netherlands (38 stations), Germany (six stations), Poland (three stations), France, Ireland, Latvia, Sweden, and the United Kingdom (one station each); stations in Italy and Bulgaria are funded to be built.

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Poster

NON-RADIAL MOTIONS OF CMES DURING SOLAR CYCLE 24 AND RISING PHASE OF SOLAR CYCLE 25

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Solar coronal mass ejections (CMEs) are sometimes deflected during their propagation. Observational and numerical studies have shown that CMEs can deflect by ten or more degrees from the source location. During the years after solar minimum the central position angle (CPA) of the CMEs tended to be offset closer to the equator with respect to that of the associated prominence eruptions (PE). No such effect was observed during solar maximum. It is known nowadays that such deflection is the consequence of an interaction between the CME and the ambient coronal field, for example, a coronal hole, or the solar wind. The CME deflection is an important factor that should be considered when studying the CMEs propagation and geoeffectiveness. In this work we study the latitudinal offsets of the PEs and CMEs during SC 24 and the rise phase of SC 25. We found a systematic offset for the rise phase of the two cycles. The average deflection angle was about 13 deg.

Poster

JOINT RESEARCH PROJECT: "ACTIVE EVENTS ON THE SUN. CATALOGS OF PROTON EVENTS AND ELECTRON SIGNATURES IN X-RAY, UV AND RADIO DIAPASON. INFLUENCE OF COLLISIONS ON OPTICAL PROPERTIES OF DENSE HYDROGEN PLASMA"

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Here we present the goals of the Joint Research Project "Active Events On The Sun. Catalogs Of Proton Events And Electron Signatures In X-Ray, UV And Radio diapason. Influence of Collisions on Optical Properties of Dense Hydrogen Plasma." Active processes on the Sun, are different manifestations of a single physical process whose source and motor are the free energy stored in the coronal magnetic fields. These various manifestations of solar activity have a significant impact on the cosmic climate as well as many processes on Earth and human activity. A number of radio signatures are associated with the shock waves generated by CME, which accelerate electrons and protons in the interplanetary space. The study of CME properties, their propagation, and their associated X-ray, ultraviolet and radio signatures are essential for predicting space weather. Impact broadening parameters for spectral lines are of interest for astrophysical, laboratory, and technological plasma, will be determined within the frame of modified semiempirical approach and other methods. The main goals of this project are to exchange the experience gained in modeling spectral lines at the Belgrade Observatory and to apply them in studying observable active processes of the Sun, creating catalogs of electronic and proton events, X-ray, ultraviolet and radio signatures and presenting them by means of the Virtual Observatory.

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Poster

SERBIAN ASTRONOMICAL JOURNAL IN THE 2014-2023 PERIOD

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The bibliographic and citation data for the Serbian Astronomical Journal in the 2014-2023 period are presented. We report on the journal acceptance rate, geographical distribution of authors and impact factor, along with other metrics.

Poster

DEMYSTIFYING NEAR-EARTH ASTEROIDS

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The Demystifying Near-Earth Asteroids (D-NEAs) project, funded by The Planetary Society, is dedicated to the development of a method for characterizing Near-Earth Asteroids using primarily ground-based data. Our approach centers around comparing the observed and theoretically predicted Yarkovsky drift. The underlying concept is to create a model capable of predicting the characteristics required to match the measured magnitude of this phenomenon. This presentation highlights the results achieved during the first year of project implementation.

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Poster

MACHINE LEARNING APPROACH FOR DISTINGUISHING DAYTIME AND NIGHTTIME IONOSPHERIC CONDITIONS ON VLF SIGNALS RELATED TO SOLAR FLARES DURING 2011

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The automated classification or labeling of ionospheric very low frequency (VLF) signals into daytime and nighttime condition categories can offer significant advantages by reducing the amount of time and effort required by researchers to manually label VLF data for further analysis and processing, e.g., in cases of studying the impacts of solar flare events on VLF data. This study employed the Random Forest (RF) classification algorithm to analyze ionospheric VLF signals during 2011, as related to several solar flare events of classes from C2. 5 to X2.1 during September that were used as a training dataset (balanced) and several solar flare events of classes from C5.5 to M1.5 during October that were used as a testing dataset. The objective was to evaluate the algorithm's efficacy in automatically classifying daytime and nighttime ionospheric conditions on VLF signals. The dataset utilized in this study consisted of various combinations of transmitters (NAA, NAU, NLK, NPM, and NLM) and receivers (Oklahoma East and South, Sheridan, and Walsenburg). The data encompassed a period of three days prior to the occurrence of the solar flare, the day of the solar flare event itself, and two days following the solar flare. The study incorporated three main features: the transmitter, receiver, and VLF amplitude data. Additionally, it employed 17 secondary features, which were statistical in nature and derived from the VLF amplitude data. These secondary features primarily consisted of rolling statistics with varying window lengths. The training dataset consisted of 113926 datapoints, while the testing dataset contained 170662 datapoints. The findings derived from the complete testing dataset reveal an area under the receiver operating characteristic curve (AUC) of 0.802 and an aggregate F1 score of 0.764. Upon analyzing the data obtained from each individual transmitter-receiver pair, it is possible to draw more detailed conclusions. In accordance with the best outcome, the achieved accuracy is 0.92, with an F1 score of 0.91 and an AUC value of 0.93. The precision and Matthew's correlation coefficient (MCC) exhibit values of 0.87 and 0.85, respectively, indicating a highly effective model that can successfully be employed for the automated classification of VLF signals during both daytime and nighttime periods. Conversely, the testing data also exhibited the most unfavorable outcome, as indicated by the AUC value, which indicated the model's inability to differentiate between daytime and nighttime conditions o n VLF signals. Additionally, the model demonstrated an MCC of 0, signifying a lack of correlation between the

predicted and actual binary classes. The utilization of the RF algorithm has shown potential in the automatic determination of daytime and nighttime conditions on VLF signals. However, to improve the predictive power of the model, further research and the inclusion of additional and expanded datasets are necessary.

Poster

ASTRONOMICAL STATION VIDOJEVICA: OBSERVATIONS FROM 2011 TO 2023

Srđan Samurović, Zorica Cvetković, Rade Pavlović

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We present the statistic of observing time used at the Astronomical Station Vidojevica (ASV) from its opening in 2011 to the current year. We analyze separately the first period, 2011-2018, when only the Nedeljković telescope (0.60 m) was available and the second period, 2018-2023, when also observations with the Milanković telescope (1.40 m) were performed. The year 2018 marks the beginning of public calls for observing time at the ASV and the reviewing of the received observational proposals by the Time Allocation Committee (TAC). Finally, we briefly analyze the scientific output produced using the telescopes mounted at the ASV, i.e., the number of printed papers in scientific journals in the 2011-2023 period.

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Poster

OPTICAL OBSERVATIONS OF SHOCK FILAMENTS IN TYCHO'S SUPERNOVA REMNANT

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We present observations of the supernova remnant Tycho obtained with GHaFaS at the William Herschel Telescope and OSIRIS at the Gran Telescopio Canaria. With the large field-of-view ($3\farcm4 \times 3\farcm4$), spatial sampling of $0\farcs2$ and high spectral resolution (FWHM of 19 km/s) of the GhaFaS instrument we covered a large portion of the remnant and were able to resolve the narrow-line Hα component (FWHM $\sim$ 10km/s). The observations revealed suprathermal narrow-line widths (>> 20 km/s) and intermediate-line component with the width of 180 km/s on average. With the OSIRIS instrument having similar field-of-view ($4' \times 4'$) and spatial sampling of $0\farcs25$ we managed to observe the same parts of the Tycho's remnant, but also resolved the broad-line component width (FWHM $\sim$ 1000 km/s). Observing all three line components at exactly the same locations along the filaments and applying shock models will give more precise information on the overall conditions in the shock, and will enable us to quantify cosmic-ray properties.

Poster

CAN WE TARGET EXTRASOLAR SYSTEMS?

Dragan Lukić

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Humanity is just getting started with space exploration, we need to finish exploring our own Solar System before we can contemplate exploring beyond it. Still, we can dream on of interstellar voyages. Immense megatons projects from fifties and up to eighties just faded away. Around year 2000, NASA abandoned idea of a multi-generation ship. New ideas from biology emerged after that. The closest star Alpha Centauri is on 276364 AU (4.37 ly). If we succeed to get fast spacecraft, a sail performing an Oberth maneuver at 0.1 AU perihelion may be accelerated to 50AU/year with new advance materials, we still need more then 5000 years to get there. Planed mission Breakthrough Starshot is a proposal to send a laser sail-driven nanocrafts to Alpha Centauri in just 20 years. After being accelerated to 20% the speed of light, this craft would conduct a flyby of Alpha Centauri. We are going to investigate and comment on problems these projects face.

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Poster

DYNAMICS OF DUAL MASSIVE BLACK HOLE SYSTEMS FORMATION IN COSMOLOGICAL SIMULATIONS

Sara Savić[1], Majda Smole[1], Miroslav Mićić[1], Ana Mitrašinović[1], Stanislav Milošević[2]

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Due to hierarchical evolution of galaxies and fact that almost all massive galaxies have supermassive black hole (SMBH) in their center, galaxy mergers lead to formation of dual SMBH systems or supermassive black hole binaries (SMBHB). In order to better understand how properties of SMBHBs depend on properties of merging galaxies, we researched these systems, circumstances of their forming and activity using the results from cosmological simulation IllustrisTNG300. We found that major mergers are the main reason for formation of dual AGNs with tendency to form more luminous AGNs. Large gas abundance is necessary for SMBH activity but its presence is not enough. Influence of redshift, SMBH mass ratio and total mass of the galaxy is consequence of dependence of merger type (whether the merger is minor or major). Number density of dual AGN in IllustrisTNG300 on redshift z=2 is 9.13×10^{-6} Mpc^{-3}.

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Poster

THE ESTIMATE OF THE INFLUENCE OF THE CLOSE VICINITY IONS AS WELL AS IONIC TEMPERATURE ONTO THE MEAN FORM OF CUT-OFF POTENTIAL FOR COMPLEX ATOMS, ARGON CASE

Zoran Simić

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There is a need for correct broadening mechanisms for the investigated models of dense plasmas. The presented investigation is a step in this direction. The argon atom, as the complex one that has been treated within the cut-off potential model, is selected as a first candidate for this approach. The ions in dense plasma posses a potential energy comparable or several tens of times stronger than kinetic, thermal energy. In such conditions it is fair estimate that ions in such plasma form relatively stiff structures. Within this frame a first order estimate is to consider a static ionic structure with thermal e nergy of ions influencing only mean inter-ionic distance. Alongside with this the far ions are screened and as such only a close vicinity ionic field is needed to be calculated more accurately, while further range ions, when needed, could be considered as point ones. The work on obtaining adequate broadening profiles based on this assumptions are carried out.

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Poster

A BOW SHOCK PULSAR WIND NEBULA: THE CURIOUS CASE OF POTOROO

Sanja Lazarević

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Pulsars and their winds are remarkable particle accelerators, producing particles with energies up to a few PeV. In the case of young and energetic pulsars, a significant fraction of their rotational energy is converted into a magnetised ultra-relativistic particle wind. This wind generates synchrotron emission observable from radio to X-rays, forming what is known as a pulsar wind nebula. When the pulsar moves supersonically through the ambient medium, it creates a bow-shaped shock in front, causing the PWN to be confined by ram pressure and resulting in a cometary morphology. Using the Australian Square Kilometre Array Pathfinder (ASKAP), we discovered an interesting example of this phenomenon, named Potoroo. Potoroo scampers through the plane of the Milky Way, displaying its complex and dynamic appearance. Combined with the Chandra archival observations, we compare its properties across the radio and X-ray spectra. Additionally, using the Parkes telescope, we identified the driving pulsar responsible for the formation of Potoroo. In the poster, I will present the characteristics of Potoroo and its contribution to our understanding of the complex interplay between pulsars, nebulae, and their environment.

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Poster

PLATFORM FOR DYNAMICAL MAPPING OF THE SOLAR SYSTEM

Nikola Knežević, Nataša Todorović

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We will present a still-developing platform that enables fast calculations of dynamical (MEGNO, FLI and encounter) maps using simple parameter settings. The platform is written in Python programming language and is based on the REBOUND N-body integrator. Orbits and ephemerides of the objects in the Solar system are taken from the Jet Propulsion Laboratory (JPL) Horizons system as a part of parameter settings in a simplified way. We will show some of the preliminary results of the software interface and efficiency including plans for its future development.

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Poster

LOCAL KINEMATICS OF A GAIA SAMPLE OF STARS

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A sample of stars from the Solar neighborhood which are within 100 pc from the Sun is formed. For all of them the newest astrometric data, products of the GAIA Mission, and line-of-sight velocities are available. The objective is to examine the local kinematics bearing in mind the usual classification into thin disc, thick disc and halo. For this purpose a catalog of galactocentric orbits is formed. In the orbit calculation the potential proposed earlier by one of the authors (SN) is used.

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Poster

THE COMPLEX SHAPE OF THE OUTFLOW EMISSION IN THE SPECTRA OF ACTIVE GALACTIC NUCLEI TYPE 2

Jelena Kovačević-Dojčinović[1], Ivan Dojčinović[2], Maša Lakićević[1], Luka Č. Popović[1]

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The accretion into super-massive black hole in active galactic nuclei (AGN) is followed by the fast motion of the emitting gas and appearance of the gas outflows. The outflow kinematics has a systemic influence on the narrow emission lines in AGN spectra and generally it contributes to the wings of the narrow emission lines. We found that in majority of the type 2 AGN spectra, the outflow contribution could be modeled by single Gaussian which fits the wings of the narrow emission lines. However, in about 2% of the AGN type 2 sample taken from SDSS, we found the extreme and complex shapes of the outflow contribution in the [O III] lines. In these objects, the strong and complex outflow contribution in [N II] and Hα lines could mimic the broad Hα with FWHM up to 2600 km/s, and give the wrong conclusion that the objects belong to the AGNs type 1.9. Here we give examples of a possible decomposition of the blended [N II]+ Hα for several SDSS AGN type 2 spectra with extreme, complex outflow emission observed in [O III] lines.

Poster

SPECTRAL INDEX VARIABILITY OF 12 BLAZARS

Miljana D. Jovanović, Goran Damljanović

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From 2013 we observed 47 candidate sources for the link between the International and Gaia Celestial Reference Frames. Observations were performed in optical V and R bands using eight telescopes in Serbia, Spain, Bulgaria, and Austria. We tested their optical spectral index variability using Abbe's criterion. The test shows spectral variability of two sources. The results for about six years of monitoring will be presented as a poster.

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Poster

IMPRINT OF THE GALACTIC ACCELERATION SCALE ON GLOBULAR CLUSTER SYSTEMS

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Mass discrepancies are observed in galaxies at galactocentric radii that are larger than the a_0 radius, i.e. the radius where the gravitational acceleration generated by baryons of the galaxy is lower than the constant $a_0 = 1.2 \times 10^{-10}$ m s^{-2}. The constant is sometimes called the galactic acceleration scale. Most galaxies are orbited by globular clusters. We found previously for massive early-type galaxies that the radial number-density profiles of their globular cluster systems are described by broken power laws and the breaks occur at the a_0 radii. We newly analyzed a catalog of globular cluster candidates in the Fornax galaxy cluster from the recent Fornax Deep Survey an d an archival HST catalog. This allowed us to confirm that 1) the agreement between the a_0 radii and the break radii of globular cluster systems is valid for early-type galaxies of all masses and 2) the same finding applies to the red and blue subpopulations of globular clusters separately. The breaks are consistent for globular cluster candidates selected photometrically and spectroscopically. We investigated preliminarily several potential explanations of the match of the break and a_0 radii, but none of them works perfectly.

Poster

ODD RADIO CIRCLES

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The discovery of Odd Radio Circles (ORCs) in the ASKAP-EMU pilot survey in 2019 has astounded astronomers worldwide. ORCs are diffuse blobs of radio emission approximately 1 arcminute in diameter which have not been seen before in radio observations, and they do not seem to correspond to any current known type of object or imaging artefact - defying conventional classification and continuing to elude our understanding. Intensive collaboration among scientists has failed to provide definitive explanations for their origin or physical mechanisms. In my poster, I will present the latest findings from our investigation into ORCs.

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Poster

NEW DATASET FOR ELECTRON-IMPACT PROCESSES INVOLVING MOLECULAR IONS OF ASTROPHYSICAL IMPORTANCE

Sanja Tošić[1], Vladimir A. Srećković[1], Veljko Vujčić[2]

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Electron-impact processes involving some small molecular ions are of critical importance in many fields, including astrophysics. We present here the new dataset for these processes. Collisional processes under consideration may have an effect on the atom excited-state populations i.e. Rydberg state populations, ionization level, and optical properties of various environments [1]. Rate coefficients for electron-impact processes involving potassium, sodium, lithium and hydrogen molecular cations in domains of higher principal quantum numbers and temperatures up to 10 000 K are presented. The outcomes, i.e., the data gathered, could be used for various applications, such as plasma chemistry or experiments, for modelling atmospheres of diverse environments such as the interstellar medium, planets, and dwarf stars, and also in the plasma fusion area [2,3]. References [1] N. Pop et al., Atomic Data and Nuclear Data Tables 139, 101414 (2021). [2] D. Albert et al., Atoms 8.4, 76 (2020). [3] V.A. Srećković et al., Data 7(9), 129 (2022). S. T. acknowledges support of the Science Fund of the Republic of Serbia, Grant No. 7749560, Exploring ultra low global warming potential gases for insulation in high-voltage technology: Experiments and modelling EGWIn.

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Poster

CROSS SECTIONS AND SWARM COEFFICIENTS FOR H+, H2+ AND H3+ IN H2

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In this work we present a cross section sets for H+, H2+ and H3+ in H2 where existing experimentally obtained data are selected and extrapolated. Monte Carlo simulation method is applied to accurately calculate transport coefficients in hydrodynamic regime. These data are needed for modeling in numerous applications of technologically important. We discuss new data for H+, H2+ and H3+ ions in H2 gas where mean and characteristic energy, flux and bulk values of reduced mobility are given as a function of reduced electric field E/N (E-electric field, N-gas density).

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Poster

RESPONSE OF THE EARTH'S LOWER IONOSPHERE TO HIGH CLASS X-RAY SOLAR FLARE EVENTS BY ANALYSIS OF VLF SIGNALS

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The lower ionospheric perturbations due to solar flare (SF) events influence propagation of electromagnetic radio signals, especially in Very Low Frequency (VLF) range of 3-30 kHz. On the other hand, disturbances in amplitude and/or phase delay of VLF radio signals, propagating within Earth- ionospheric waveguide, reflect changes in lower ionospheric plasma properties and thus make the VLF technique as a good remote sensing tool for ionospheric D-region (50-90 km) probing. Analysis of similarities and differences in the lower ionospheric response to intense solar activity in form of two strong X-ray solar flare events, at the opposite sides of the same highest X-class range, was carried out. A case study included SFs of X1.3 and X9.3 class, as recorded by Belgrade VLF system on 7th and 6th September, 2017, respectively. Solar X-ray data were obtained from GOES database. Changes in the lower ionosphere induced by these sudden events were monitored on two VLF signals propagating from USA and UK. Based on VLF signal recordings, numerical simulations were conducted and variation of propagation parameters of sharpness and reflection height was estimated, giving accordingly the electron density height profiles for these events. According to model computations, these events significantly affected lower ionosphere revealing an increase of electron density of a few orders of magnitude, as compared to unperturbed ionospheric conditions, although ionospheric plasma properties differ for analysed cases.

Programme of the Conference

Monday 16th October – Main Hall

8:30 Registration

Opening of the conference

9:30 – 10:00 Opening ceremony (representatives from the Astronomical Observatory of Belgrade, Mathematical Faculty and Serbian Academy of Sciences and Arts)

Plenary talks – Chair Dušan Marčeta
10:00 – 10:45 Wolfram Kollatschny - Variability of AGN

10:45 – 11:30 Petr Kurfürst - Supernovae as tracers of the structure and evolution of the surrounding universe

11:30 – 12:00 Coffee break

12:00 – 12:45 Miroslav Filipović – Per Aspera Ad Astra

12:45 - 13:30 Claudia Raiteri - Monitoring blazar variability to understand extragalactic jets

13:30 – 14:30 Lunch break

Special Session – Neutrino astrophysics – Chair: Jelena Petrović
14:30 – 15:15 Dmitry Naumov - Baikal-GVD Neutrino Telescope: Unlocking the Secrets of the Universe's Catastrophic Events

15:15 – 15:45 Liudmila Kolupaeva - Current status and future prospects of three-flavor oscillations' measurements with accelerator neutrino beams

15:45 – 16:15 Evgeny Yakushev - Nuclear spectroscopy, Neutrino physics and Astrophysics

16:15 – 16:30 Coffee break

16:30 – 17:00 Sergey Rozov - Direct search for Dark Matter in underground experiments

17:00 – 17:30 Maxim Gonchar - Long and medium baseline experiments with reactor antineutrinos

17:30 – 18:00 Jelena Petrović (moderator) - Discussion about the future collaboration of Serbia with the Baikal experiment

18:00 – 19:30 Welcome cocktail

Tuesday 17th October – Hall 2

Extragalactic astronomy (I) – chair: Srdjan Samurović
9:30 – 10:00 Michal Bilek - Origin of the diversity of rotational support of early-type galaxies

10:00 – 10:30 Marcel S. Pawlowski - How Phase-Space Correlations of Systems of Satellite Galaxies Challenge λ-CDM Cosmology

10:30 – 10:50 Ana Lalović - Specific angular momentum correlation with the number of satellites

10:50 – 11:10 Milena Jovanović – Baryonic mass in nearby galaxies (PhD Thesis)

11:10 – 11:30 Ana Mitrašinović - The importance of interaction strength for non-merger galaxy encounters (PhD Thesis)

11:30 – 11:50 Coffee break

Stellar physics and physics of the interstellar medium (I) – chair: Jelena Petrović
11:50 - 12:20 Surjit Wadhwa - Identification of Potential Red Nova Progenitors

12:20 – 12:50 Mauricio Cabezas - Satellite Lines in the Interacting Binary V356 Sgr

12:50 – 13:20 Juan Garces Letelier - Magnetic activity effects in orbital light curves of binary systems

13:20 – 13:40 Brankica Kubatova - X-Shooting ULLYSES: Massive Stars at low metallicity

13:40 – 14:00 Anastasiya Yarovova - Massive stars and diffuse emission sources in the galaxy IC 1613

14:00 – 15:00 Lunch break

Interdisciplinary studies – chair: Vladimir Zeković
15:00 – 15:30 Vladimir Srećković - Research of the Impact of Strong Solar Flares: Multi-instrumental investigation

15:30 – 16:00 Aleksandra Nina - Reduction of the VLF signal noise as potential earthquake precursor: pilot studies

16:00 – 16:20 Saša Dujko - Electron transport and streamer discharges in the atmosphere of Primordial Earth

16:20 – 16:40 Dragan Lukić - We can spread our genetic material

16:40 – 17:00 Nikola Veselinović - Results from solar weather research at Low-background Laboratory for Nuclear Physics

17:00 – 17:30 Coffee break

Astrophysical spectroscopy and interferometry (I) – chair: Miroslav Mićić
17:30 – 17:50 Marko Stalevski - Dissecting the active galactic nucleus in Circinus galaxy

17:50 – 18:10 Majda Smole - Accelerating MCRT simulations using dimensionality reduction techniques and INLA

18:10 – 18:30 Jasmina Blečić - A New Era of Exoplanetary Modelling Commenced by First JWST Observations

Wednesday 18th October – Hall 2

Extragalactic astronomy (II) – chair: Jelena Kovačević - Dojčinović
9:30 – 10:00 Alok Chandra Gupta - Multi-wavelength Variability and Quasi Periodic Oscillations (QPOs) in Blazars

10:00 – 10:20 Ivana Damjanov – Histories of Galaxies in the Middle-Aged Universe

10:20 – 10:40 Stanislav Milošević - Properties of the tidal substructures in the Andromeda galaxy (PhD Thesis)

10:40 – 11:00 Milan Milošević – Fast numerical test of inflationary models

11:00 – 11:20 Ivana Ebrova - Deep imaging with Milankovic telescope: Linking merger history to kinematics of elliptical galaxies

11:20 – 11:50 Coffee break

Astrophysical spectroscopy and interferometry (II) – chair: Nataša Bon
11:50 – 12:10 Ivan Milić - Spectropolarimetric Inversions using Convolutional Neural Networks

12:10 – 12:30 Slobodan Jankov - Largest astronomical optical telescopes

12:30 – 12:50 Oliver Vince - Development of a Multifunctional Instrument for the 1.4m Milanković Telescope

12:50 -14:30 Lunch break

14:30 Excursion

Thursday 19th October – Hall 2

Stellar and galactic systems – chair: Vladimir Zeković
9:30 – 9:50 Milan Stojanović– Kinematics of Type II Cepheid pulsating stars

9:50 – 10:10 Miroslava Vukčević - Dynamics of spiral galaxies in nonlinear regime

10:10 – 10:30 Milan S. Dimitrijević - On the Stark broadening of spectral lines of highly ionized iron for the investigation of neutron stars

10:30 – 11:00 Coffee break

Extragalactic astronomy (III) – chair: Edi Bon
11:00 – 11:30 Dragana Ilić, Andjelka Kovačević - Investigation of active galactic nuclei in the Legacy Survey of Space and Time (LSST)

11:30 – 11:50 Mirjana Pović - Evidence of positive AGN feedback in the green valley

11:50 – 12:10 Sladjana Knežević - MUSE-NFM observations of the Circinus active galactic nucleus

12:10 – 12:30 Marina Pavlović - The influence of interactions of distant galaxies on their non-thermal radio emission

12:30 – 12:50 Aleksandra Božilović - Dusty winds in active galactic nuclei (Master Thesis)

12:50 – 14:30 Lunch break

Astrometry, dynamical astronomy and planetology – chair: Nataša Todorović
14:30 – 15:00 Darryl Seligman - Interstellar Interlopers and Dark Comets

15:00 – 15:20 Dušan Marčeta - Orbital Structure of Interstellar Objects in the Solar System

15:20 – 15:40 Kristina Klopić - Analysis of the 77899 (2001 TS117) asteroid family

15:40 – 16:00 Rade Pavlović - Confidence Region for Orbital Elements of Visual Binaries

16:00 – 16:20 Marija Janković - Vertical structure of debris discs and collisional damping

16:20 – 16:50 Coffee break

16:50 – 19:00 Poster session

20:00 Conference dinner

Friday 20th October – Hall 2

Stellar physics and physics of the interstellar medium (II) – chair: Bojan Arbutina
9:30 – 10:00 Damiano Caprioli - New Developments in Shock Acceleration

10:00 – 10:20 Vladimir Zeković - Non-linear evolution of SLAMS turbulence and its role in particle acceleration at astrophysical shocks

10:20 – 10:40 Kristina Racković Babić - Interstellar dust flux variation near 1 AU: insights from STEREO/WAVES and Wind/WAVES instruments

10:40 – 11:00 Coffee break

Astrometry, dynamical astronomy and planetology - chair Dušan Marčeta
11:00 – 11:30 Nataša Todorović - About some near-Earth orbits

11:30 – 11:50 Evgeny Smirnov - A machine-learning approach to the problem of identification asteroids in mean-motion resonances and asteroid families

11:50 – 12:10 Miljana D. Jovanović, Goran Damljanović - Ten years of monitoring of 1722+119 at ASV

12:10 – 12:30 Ivana Milić Žitnik - The equation between 3-body mean motion resonances and Yarkovsky drift speeds on eccentricities higher than 0.1

12:30 – 14:00 Lunch break

History, philosophy and teaching of astronomy (I) – chair: Dušan Onić
14:00 – 14:20 Milica Vučetić – Astronomy education in Serbia 2020-2023

14:20 – 14:40 Bojan Arbutina - The life and work of Elia Millosevich (1848-1919)

14:40 – 15:00 Nedeljko Todorovic, Natalija Janc, Milivoj Gavrilov – Scientific work of Wenceslas S. Jardetzky and collaboration with Milutin Milankovic

15:00 – 15:20 Marina Pavlović - Astronomy education through digital media

15:20 – 15:50 Coffee break

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15:50 – 16:10 Branislav Rovčanin - New events in the Astronomical society „Ruđer Bošković“

16:10 – 16:30 Sonja Vidojević – Serbia in astronomical contests between 2020 and 2023

16:30 – 16:50 Damnjan Milić – Department of Astronomy at Petnica Science Center 2021 – 2023

16:50 – 17:10 Zoran Tomić – Project of the first urban astronomical observatory in Kruševac

17:10 - 17:15 Jelena Petrović - Closing remarks

17:30 Assembly of the Society of Astronomers of Serbia

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M. Dechev, K. Kozarev - LOFAR-BG - Development and Current State

K. Koleva, N. Gopalswamy1, S. Yashiro, M. Dechev - Non-radial motions of CMEs during Solar Cycle 24 and rising phase of Solar Cycle 25

M. Dechev, Z. Simic, R. Miteva, K. Koleva, N. Sakan - Active Events On The Sun. Catalogs Of Proton Events And Electron Signatures In X-Ray, Uv And Radio diapason. Influence of Collisions on Optical Properties of Dense Hydrogen Plasma

Milena Jovanović, Bojan Arbutina, Dejan Urošević – Serbian Astronomical Journal in the 2014 – 2023 period

Dušan Marčeta, Bojan Novaković, Marco Fenucci, Debora Pavela - Demystifying Near-Earth Asteroids

Filip Arnaut, Aleksandra Kolarski - Machine Learning Approach for Distinguishing Daytime and Nighttime Ionospheric Conditions on VLF Signals related to Solar Flares During 2011

Srdjan Samurović, Zorica Cvetkovic, Rade Pavlović - Astronomical Station Vidojevica: Observations from 2011 to 2023

S. Knežević, S. Schulze, J. Mendez-Abreu, G. van de Ven, G. Morlino - Optical observations of shock filaments in Tycho's supernova remnant

Dragan Lukić - Can we target extrasolar systems?

Sara Savić - Dynamics of dual massive black hole systems formation in cosmological simulations

Zoran Simić - The estimate of the influence of the close vicinity ions as well as ionic temperature onto the mean form of cut-off potential for complex atoms, argon case

Sanja Lazarević - A Bow Shock Pulsar Wind Nebula: The Curious Case of Potoroo

Nikola Knežević - Platform for dynamical mapping of the Solar system

Milan Stojanovic, Slobodan Ninković – Local kinematics of a Gaia sample of stars

Sladjana Marčeta Mandić – TBA

Jelena Kovačević Dojčinović - The complex shape of the outflow emission in spectra of active galactic nuclei type 2

Miljana D. Jovanović, Goran Damljanović - Spectral index variability of 12 blazars

Michal Bilek - Imprint of the galactic acceleration scale on globular cluster systems

Peter Macgregor - Odd Radio Circles

Sanja Tošić, Vladimir Srećković - New dataset for electron impact processes involving molecular ions of astrophysical importance

Željka Nikitović - Cross Sections and Swarm Coefficients for H+, H2+ and H3+ in H2

Aleksandra Kolarski - Response of the Earth's Lower Ionosphere to High Class X-Ray Solar Flare Events by Analysis of VLF Signals

Ana Lalović, Sladjana Knežević - Study of NGC4473: double-sigma galaxy

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