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ACTIVITIES OF THE SERBIAN EUROPLANET GROUP WITHIN EUROPLANET SOCIETY

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Abstract. Europlanet society connects many different scientific institutions all over the world. The Serbian Europlanet Group (SEG) was established at 2019. It currently has 20 active scientists from 6 institutions working in Serbia in different fields of planetary science as well as related fields. Here are presented activities of SEG in 2020.

1. INTRODUCTION

The European society promotes the European planetary science as well as related fields. Its aims are to support the development of planetary science at a national and regional level, particularly in countries and areas that are currently under–represented within the community, and early career researchers who established their network within the Europlanet: the Europlanet Early Career (EPEC) network ($https://www.europlanet-society.org/early-careers-network/$). The Europlanet consists of 10 Regional Hubs. More information about organization and activities of this society can be found at the website $https://www.europlanet-society.org/$.

Serbia is one of six countries included in the Southeast European Hub that was established in 2019. The Serbian Europlanet Group (SEG) currently consists of 20 members from 6 institutions. Details of members and activities of SEG can be found at the website $https://www.europlanet-society.org/europlanet-society/regional-hubs/southeast-europe/$. In this paper are described main activities and presented scientific research of SEG members related to the Europlanet fields in 2020.

2. CONFERENCES AND WORKSHOPS OF SEG 2020

2. 1. PARTICIPATION IN THE EUROPLANET SCIENCE CONGRESSES

The Europlanet Science Congress (EPSC) is the annual meeting of the Europlanet Society. In the Europlanet Science Congress 2020, seven scientists from Serbia participated with several lectures. It was first virtual EPSC congress attended by 1168 participants from 49 countries. Here, will be mentioned two of SEG participants.

Dušan Marčeta presented research about population of interstellar asteroids and possibility that one of the observational selection effects, known as Holetschek's effect, could be used for preliminary estimation of the size-frequency distribution of this population. Aleksandra Nina presented research on new methodology for earthquake prediction which was partially realized within the Europlanet workshop in Petnica Science Center in 2019.

2. 2. PARTICIPATION IN THE XII SERBIAN–BULGARIAN ASTRONOMICAL CONFERENCE

Serbian scientists organized a Europlanet session with several lectures during the XII Serbian–Bulgarian Astronomical Conference (SBAC 12). SBAC 12 was held in Sokobanja from September 25 to 29, 2020 (Popović et al. 2020). SEG presented its work (Nina et al. 2020a) and discussed with Bulgarian colleagues and with colleagues from Europlanet Southeast HUB countries about expanding of their cooperation.

2. 3. PARTICIPATION IN THE XIX SERBIAN ASTRONOMICAL CONFERENCE

The work of SEG was presented during the XIX Serbian Astronomical Conference (19 SAC), held at the Serbian Academy of Sciences and Arts in Belgrade from October 13 to 17, 2020 (Kovačević et al. 2020). Aleksandra Nina participated with invited lecture about investigation of the lower ionosphere disturbances as possible earthquake precursors and application of research of the lower ionosphere influences in Earth observations by satellite during influence a solar X-ray flare. Ivana Milić Žitnik gave progress report about asteroid's motion with orbital eccentricity in the range (0, 0.2) across the 2-body mean motion resonances with Jupiter with different strengths due to the Yarkovsky effect (Milić Žitnik & Novaković 2016, Milić Žitnik 2020a).

3. RESEARCHES OF SEG MEMBERS AT 2020

SEG members are scientists in different research fields. Here are a few researches that are in the areas of Europlanet.

3. 1. ASTRONOMY

3.1.1. Model of interstellar asteroids and expected predominance of retrograde object among the discovered objects

Dušan Marčeta and Bojan Novaković examined the model of interstellar asteroids and comets and found analytical expressions for the distributions of their orbital elements (Marčeta & Novaković 2020). They payed special attention to objects which could be detectable by future LSST survey. Also, they found that majority of these objects should move along retrograde orbits resulting in asymmetry of the distribution of

their orbital inclinations. Finally, they found that this asymmetry is a result of the Holetschek effect. Since this effect is size-dependant, its influence is stronger for populations with steeper size-frequency distributions since they are comprised of larger number of smaller objects. This fact could be used for preliminary estimation of the size-frequency distribution of the underlying true population of interstellar objects once when sufficient number of objects become discovered.

3.1.2 The relationship between the 'limiting' Yarkovsky drift speed and asteroid families' Yarkovsky V-shape

Ivana Milić Žitnik examined the relationship between asteroid families' V-shapes and the 'limiting' diameters in the $(a, 1/D)$ plane. Following the recently defined 'limiting' value of the Yarkovsky drift speed at 7×10^{-5} au/Myr (Milić Žitnik 2019), she decided to investigate the relation between the asteroid family Yarkovsky V-shape and the 'limiting' Yarkovsky drift speed of asteroid's semi-major axes. She has used the known scaling formula to calculate the Yarkovsky drift speed in order to determine the inner and outer 'limiting' diameters (for the inner and outer V-shape borders) from the 'limiting' Yarkovsky drift speed. The method was applied to 11 asteroid families of different taxonomic classes, origin type and age, located throughout the Main Belt. Her main conclusion was that the 'breakpoints' in changing V-shape of the very old asteroid families, crossed by relatively strong mean motion resonances on both sides very close to the parent body, are exactly the inverse of 'limiting' diameters in the a versus $1/D$ plane. This result uncovers a novel interesting property of asteroid families' Yarkovsky V-shapes (Milić Žitnik 2020b).

3.1.3 Astrobiology-habitability of exoplanets

Balbi, Hami and Kovačević (2020) present a new investigation of the habitability of the Milky Way bulge, that expands previous studies on the Galactic Habitable Zone. This work discusses existing knowledge on the abundance of planets in the bulge, metallicity and the possible frequency of rocky planets, orbital stability and encounters, and the possibility of planets around the central supermassive black hole. Another concern for habitability is the presence of the supermassive black hole in the Galactic center, but also in nearby Active galactic nuclei, that could have resulted in a substantial flux of ionizing radiation during its past active phase, causing increased planetary atmospheric erosion and potentially harmful effects to surface life as shown by Wislocka, Kovačević, Balbi (2019). This work was featured in famous Forbes Magazine in their section Innovavations. Andjelka Kovačević is a member of Working group of habitability of exoplanets of European astrobiology institute.

3. 2. GEOPHYSICS

3.2.1 Atmospheric aerosol remote sensing and modelling

The EARLINET lidar network was established with the goal of creating a quantitative, comprehensive, and statistically significant database for the horizontal, vertical, and temporal distribution of aerosols on a continental scale. Within the network Belgrade lidar station was involved in initiative for studying the changes in the atmosphere's structure, its dynamics, and its optical properties during the COVID-19 lock-down by comparison to the aerosol climatology in Europe. Near real time de-

livery of the data and fast analysis of the data products proved that aerosol lidars are useful for providing information not only for climatological purposes, but also in emergency situations like detecting airborne hazards for aviation (Papagiannopoulos et al. 2020). The preliminary results indicate that the lock-down did not affected the high troposphere, but for the low troposphere a certain effect can be seen. In addition, ongoing activities are related to the participation in ESA ADM-Aeolus mission (the first high-spectral resolution lidar in space) Cal/Val activity through validation of L2A products of aerosol profiles and studying the relationship between satellite AOD measurements and ground PM concentrations (Mijić & Perišić 2019).

3.2.2 Lower ionosphere

The lower ionosphere research was a continuation of research related to a possible new type of earthquake precursor in the form of signal noise amplitude reduction (Nina et al. 2020b) and examinations of the effects of the D-region which is disturbed by a solar X-ray flare on satellite signals (Nina et al. 2020c). Also, a new model for determining ionospheric parameters in the unperturbed D-region was developed.

3.2.3 Investigation of a possible lithosphere-ionosphere coupling through seismo-ionospheric effect

Possible relationship between amplitude and phase delay characteristics of the NWC/19.8 kHz signal transmitted from H. E. Holt in Australia (φ = 21.8° S, Λ = 114.16° E) towards Belgrade AbsPAL receiver (φ = 44.85° N, Λ = 20.38° E) in Serbia and seismic activity reported by Helmholtz-Zentrum Potsdam - Deutsches GeoForschungsZentrum GFZ in period from December 2005 to June 2007 was investigated with the main result presented in Kolarski and Komatina (2020).

3.2.4 Satellite radar technique for atmospheric water vapor measurement and modelling effects of the ionospheric disturbances

Satellite observation and measurements performed by the Synthetic Aperture Radar (SAR) and the Interferometric Synthetic Aperture Radar (InSAR) technique can be used for acquiring more information about the water vapor present within the atmosphere. The methodology of the SAR instrument and the InSAR technique is described in Radović (2020). Additionally, the focus is set on the four different satellites with SAR instruments working on different frequencies. Apart from that, in Radović (2020) is presented how neglecting the ionospheric perturbations which took place during the satellite measurements can influence modelling of the water vapor parameters derived from such measurements acquired by the SAR instruments carried by the mentioned satellites.

3. 3. ASTROPHYSICS

3.3.1. Atomic Molecular and Optical Physics group of researchers at the Laboratory for Atomic Collision Processes

LACP[1], Institute of Physics Belgrade, University of Belgrade, has been studying several collisional processes that involve electron scattering by atomic particles (e.g. for

[1] *http : //mail.ipb.ac.rs/ centar3/acp.html*

helium Jureta et al. (2014)) and laser interactions with gases (Rabasović et al. 2019), nanopowders (Šević et al. 2020a,b) and single crystal phosphors (Šević et al. 2021). Electron impact cross sections are relevant parameters in modelling of processes that occur in cometary coma (Marinković et al. 2017), collisional processes in AGNs (Dimitrijević et al. 2021) or Earth' s and other planets' atmospheres (Vukalović et al. 2021). Due to the immense importance of having full survey and accurate data of electron cross sections, there are several databases that maintain large sets of electron collisional data and even more, a unique portal for accessing such kind of data have been created through European framework programs (for a recent update of the Virtual Atomic and Molecular Data Centre[2] – VAMDC see e.g. Albert et al. (2020)).

BeamDB (Belgrade electron-atom/molecule DataBase[3]) is a collisional database that is maintained by the researchers of the LACP and it covers interactions of electrons with atoms and molecules in the form of differential (DCS) and integral cross sections for the processes such as elastic scattering, excitation and ionization (Jevremović et al. 2020). At present the output files that come from the search of BeamDB are present in the xml format of specific syntax developed by the International Atomic Energy Agency (IAEA)[4]. These so called "xsams" files contain full record of data sets including bibliographical entities, but the process of extracting values of cross sections is hard for researchers. That is why this group started to develop a converter which will convert xsams file into textual format file with simple columns that list values of impact energy, scattering angle, DSC and corresponding uncertainty. The next step would be adding a graphical presentation to the webpage of the BeamDB database. The graphics should present logarithm of DCS data points with error bars associated to the uncertainty versus impact energy and scattering angle in 3D graph.

Exploiting the fact that BeamDB contains large sets of DCS values obtained both experimentally and theoretically, they are in the process of developing machine learning algorithms for determining extrapolated DCS in the regions which are not accessed by experiments (Ivanović et al. 2020). The primary goal is to determine extrapolated values toward zero scattering angle as well as to large angles, usually from 150° to 180°.

It is envisaged that the BeamDB will contain electron spectroscopy data as well, beside the cross section data. At present, there is only a single threshold photoelectron spectrum of argon curated in the BeamDB, but the plans are to add energy loss spectra, presumably obtained in the LACP. This would allow them to develop tools for spectral classification and particular spectra identification based on data-mining methods. An overview of various data mining methods has been recently presented by Yang et al. (2020).

3.3.2. A&M data for stellar atmosphere modelling

Work on topics of modelling various astrophysical and laboratory plasma which are of interest for Europlanet community is continued. A&M datasets e.g. rate coefficients, Stark broadening parameters, line profiles, etc. are published during this year (see

[2] $https://portal.vamdc.eu/vamdc_portal/$
[3] $http://servo.aob.rs/emol$
[4] $https://www-amdis.iaea.org/xsams/documents/$

some of the papers: Srećković et al. 2020; Majlinger et al. 2020; Dimitrijević et al. 2020). Part of the data are hosted on SerVO at AOB[5].

4. CONCLUSION AND FURTHER WORK

In this paper are presented activities of Serbian scientists within Europlanet society. In the first part of the paper, are described briefly conferences that occurred in 2020 which promoted work of Serbian Europlanet Group. In the second part are presented several studies of SEG important for the Europlanet research fields. Serbian scientists plan to continue work within Europlanet society in the following years and to promote the Europlanet and SEG activities, as well as to expand SEG.

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[5]see e.g. *http : //servo.aob.rs/mold*

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