Integrations of satellite and ground-based observations and multi-disciplinarity in research and prediction of different types of hazards in Solar system

May 10-13, 2019, Petnica Science Center, Valjevo, Serbia

BOOK OF ABSTRACTS

Edited by Aleksandra Nina, Milan Radovanović and Vladimir A. Srećković

europlanet NA1 – Innovation Through Science Networking
Task 2 – Scientific Working Groups

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CONTENTS

Abstracts of Invited Lectures

Darko Jevremović
SOLAR SYSTEM OBJECTS IN THE LSS ERA (ASSESSING THE HAZARDS)..... 9–9

Pál Gábor Vizi, Péter Szutor, Szaniszló Bérczi, Szilárd Csizmadia, Tibor Hegedűs
TRAJECTORY AND ANALYSIS OF LOCAL FIREBALL-METEORITE EVENTS AND EXTENDED METEOR HUNTING WITH SMARTPHONES AS 'SKY EVENT' CAMERAS..... 10–12

Sergey Pulinets, Dimitar Ouzounov
INTEGRATION OF SATELLITE AND GROUND-BASED OBSERVATIONS AND MULTI-DISCIPLINARITY IN EARTHQUAKE AND VOLCANO ERUPTION FORECAST BASED ON THE LAIC PHYSICAL MODEL..... 13–14

Pier Francesco Biagi
THE INFREP VLF/LF RADIO NETWORK FOR STUDYING EARTHQUAKE PRECURSORS: PRESENT SITUATION AND RECENT RESULTS..... 15–16

Konstantinos Kourtidis, Veronika Barta, Jozsef Bor, Evgeny Mareev, Christina Oikonomou, Colin Price, Sergey Pulinets
WORK WITHIN THE COST ACTION ELECTRONET ON THE COUPLING OF THE ATMOSPHERIC ELECTRIC CIRCUIT TO EARTHQUAKES, LIGHTNING AND THE SUN-EARTH ENVIRONMENT..... 17–17

Giovanni Nico, Weike Feng, Olimpia Masci, Motoyuki Sato, Luciano Garramone
RADAR INTERFEROMETRY AS A NEW TOOL FOR EARTHQUAKE GEOTECHNICAL ENGINEERING..... 18–19

Nikola Veselinović, Mihailo Savić, Aleksandar Dragić, Dimitrije Maletić, Dejan Joković, Radomir Banjanac, Vladimir Udovičić, David Knežević
CORRELATION OF SOLAR WIND PARAMETERS WITH COSMIC RAYS OBSERVED WITH GROUND STATION..... 20–20

Dejan Vinković, Maria Gritsevich
THE CHALLENGES OF HYPERVELOCITY MICROPHYSICS RESEARCH IN METEOROID IMPACTS INTO THE ATMOSPHERE..... 21–22

Slavica Malinović-Milićević, Zoran Mijatović, Ilija Arsenić, Zorica Podrašćanin, Ana Firanj Sremac, Milan Radovanović, Nusret Drešković
THE IMPORTANCE OF GROUND-BASED AND SATELLITE OBSERVATIONS FOR MONITORING AND ESTIMATION OF UV RADIATION IN NOVI SAD, SERBIA..... 23–23

Yaroslav Vyklyuk, Milan Radovanović, Slavica Malinović-Milićević
DEEP LEARNING LSTM RECURRENT NEURAL NETWORK FOR CONSEQUENCE FORECASTING OF THE SOLAR WIND DISTURBANCE..... 24–25

Milan S. Dimitrijević
MILUTIN MILANKOVIĆ AND CLIMATE CHANGES LEADING TO ICE AGES..... 26–27

Aleksandar Valjarević, Nikola Bačević, Marko Ivanović
DIGITAL AND NUMERICAL METHODS IN ESTIMATION OF A HAZARD FLOODS IN THE MUNICIPALITY OF OBRENOVAC..... 28–28

Abstracts of Progress Reports

Aleksandra Nina, Giovanni Nico, Luka Č. Popović, Vladimir M. Čadež, Milan Radovanović
NATURAL DISASTERS AND LOW IONOSPHERIC DISTURBANCES DETECTED BY BELGRADE VLF/LF RECEIVER STATION..... 31–32

Sergey Pulinets
THE ROLE OF GALACTIC COSMIC RAYS IN DYNAMICS OF HURRICANES AND TYPHOONS AND GLOBAL CHANGE..... 33–34

Bozhidar Srebrov, Ognyan Kounchev, Georgi Simeonov
ANALYSIS OF BIG DATA IN GEOMAGNETISM VIA WAVELET ANALYSIS..... 35–35

Nataša Todorović
DYNAMICAL ORIGIN OF TWO POTENTIALLY HAZARDOUS ASTEROIDS..... 36–36

Andjelka B. Kovačević
PLANETARY ATMOSPHERES EROSION DUE TO Sgr A AND (z<0.5) ACTIVE GALACTIC NUCLEI RADIATION..... 37–37

Dušan Marčeta, Bojan Novaković
STARDUST-RELOADED: THE ASTEROID AND SPACE DEBRIS NETWORK..... 38–38

Abstracts of Posters

Veljko Vujčić, Darko Jevremović
NEO DETECTION USING COMPLEX EVENT PROCESSING..... 41–41

Aleksandra Kolarski
ATMOSPHERIC DISTURBANCES DUE TO SEVERE STORMY WEATHER..... 42–42

Jelena Petrović, Snežana Dragović
RADON AS POTENTIAL EARTHQUAKE PRECURSOR..... 43–44

Predrag Jovanović, Duško Borka, Vesna Borka Jovanović
CONSTRAINING YUKAWA GRAVITY FROM PLANETARY MOTION IN THE SOLAR SYSTEM... 45–46

Bratislav P. Marinković, Stefan Ivanović, Nebojša Uskoković, Milutin Nešić
ELECTRON-IMPACT CROSS SECTIONS FOR THOLINS: COVERAGE WITHIN BEAMDB DATABASE..... 47–48

Milan Radovanović, Aleksandra Nina, Vladimir A. Srećković
EXTREME SOLAR RADIATION AND NATURAL DISASTERS: CROSS DISCIPLINARY APPROACHES..... 49–49

Vladimir A. Srećković
SOLAR ACTIVITY, NATURAL HAZARDS, LOW IONOSPHERIC PERTURBATIONS AND SATELLITE AND GROUND-BASED OBSERVATIONS..... 50–50

Zoran Mijić, Mirjana Perišić
COMPARISON OF MODIS AEROSOL OBSERVATIONS AND GROUND-BASED PM MEASUREMENT FOR THE BELGRADE REGION..... 51–52

PROGRAMME..... 53–55

LIST OF POSTERS..... 56–56

AUTHORS' INDEX..... 57–57

PARTICIPANTS..... 58–59

ABSTRACTS OF INVITED LECTURES

Invited Lecture

SOLAR SYSTEM OBJECTS IN THE LSS ERA (ASSESSING THE HAZARDS)

Darko Jevremović[1]

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The Large Synoptic Survey is a ten year project which aims to map the visible sky from its site approximately twice a week. That will be achieved using 8.4 m telescope currently built at the mountaintop Cerro Pachon in northern Chile. The first light is expected in 2020 and the survey will start in 2022. The telescope will have an 8.4m (6.5 effective)primary mirror, a large field of view(9.6 sq. degrees) and a largest astronomical camera ever built (3.2Gpx). The standard observing sequence will consist of pairs of 15-second exposures in a given field, with two such visits in each pointing in a given night. Each visit will achieve depth of 24.5 in r. The LSST design is driven by four main science themes: probing dark energy and dark matter, taking an inventory of the Solar System, exploring the transient optical sky, and mapping the Milky Way.

Collisions in the main asteroid belt between Mars and Jupiter still occur, and occasionally eject objects on orbits that may place them on a collision course with Earth. Studying the properties of main belt asteroids at sub-kilometer sizes is important for linking the near-Earth Object (NEO) population with its source in the main belt. About 20% of NEOs are the potentially hazardous asteroids (PHAs) with orbits that pass sufficiently close to Earth's orbit (within 0.05 AU). Perturbations with time scales of a century can lead to intersections and the possibility of collision. SSO are moving with a wide range of apparent velocities - from several degrees per day for NEOs to a few arc seconds per day for the most distant TNOs.

I will review projected perfomace of LSS depending on different proposed cadences and a current status of development of software which will enable discovery, calculation of orbits and assessment of risks from SSO objects.

Invited Lecture

TRAJECTORY AND ANALYSIS OF LOCAL FIREBALL-METEORITE EVENTS AND EXTENDED METEOR HUNTING WITH SMARTPHONES AS 'SKY EVENT' CAMERAS

Pál Gábor Vizi[1], Péter Szutor[1], Szaniszló Bérczi[2], Szilárd Csizmadia[3], Tibor Hegedűs[4]

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Introduction

We present our investigations about last Carpatian Basin's bigger Fireball events. Biggest was the 2010.02.28. 22:24:44 UTC fireball event 'Košice' Meteorite. This work is about our methods to calculate and find the trajectory and pieces of this fireball-meteorite event by post calibrations of cameras.

The medium sized fireball events are usually not documented analytically. The small meteor events, e.g. meteor showers are caused by sand sized grains and almost all of them disintegrate and never reach the Earth's surface. However, they are observed on thy sky as paths radiating when they entry to the higher atmosphere. They can be analyzed chemically from spectrograms of pictures and videos of meteor surveillance cameras and have a large documented data. Large meteor events are well documented from physical and chemical analysis of pieces. We describe a new and very cost effective method which became available nowadays for fireball and meteor hunting by deploying smartphones or tablets - using the spare time of them or with reusing old phones - to extend and expand the possibilities to collect more fireball and meteor tracking data and to position falling.

Preliminaries

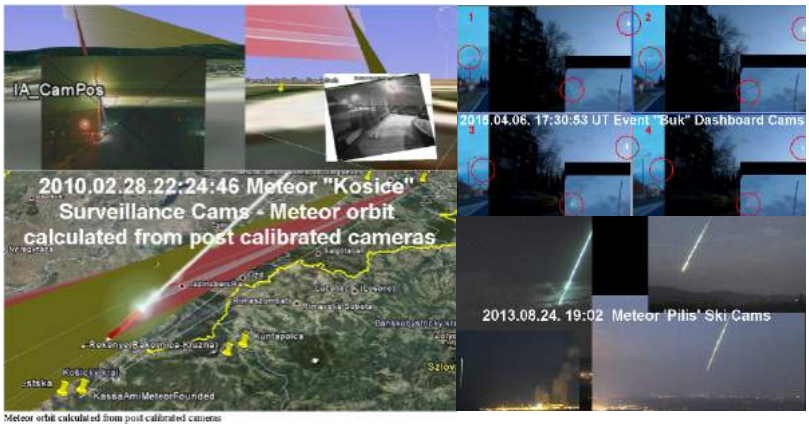
Authors described in their previous works some methods and examples of successful meteor hunting by gaining information from accidental random fireball records of surveillance or ski resort cameras and gave some methods about estimating the components of medium sized meteors which don't give discoverable amount of fallen pieces (Kubovics, Vizi, & Bendő, 2012; TheUserAZ09, 2017; Vizi et al., 2013). We use Android phones and all of them can handle more accounts. We suggest to create account login names from locations(GPS), azimuth and altitude degrees (Vizi, Berczi, Csizmadia, & Hegedus, 2016).

Examples

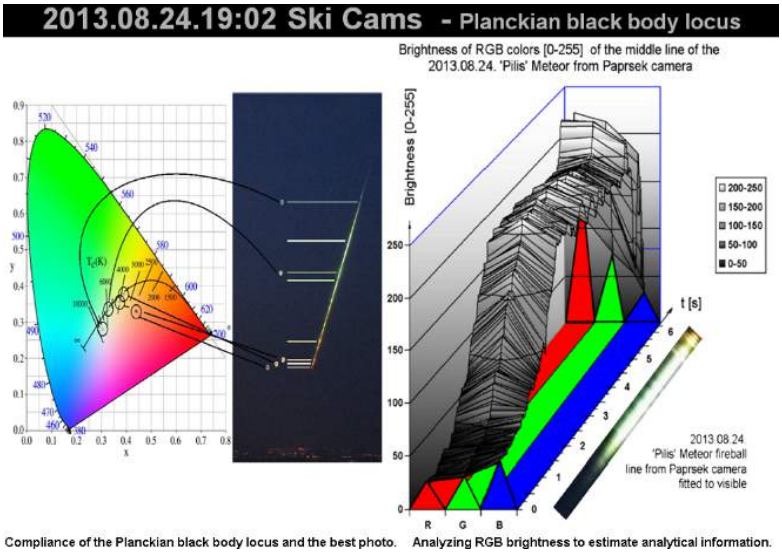
We analyzed fallen pieces of Meteor 'Košice' and we estimated the composition of the medium sized 'Pilis' event from brightness of RGB colors using the Planckian black body locus diagram (Vizi et al., 2013).

We collected and processed some recent events. We tried to synchronize videos of the same events using timing of the most reliable time data and the brightness of the fireball through the frames of the video. Results are collected into a multi window video where main flash frames are the synchronous events of the serial of frames.

Smartphones give similar good quality as visible in examples and expectable higher resolution in future.



Meteor orbit calculated from post calibrated cameras



Compliance of the Planckian black body locus and the best photo. Analyzing RGB brightness to estimate analytical information.

Summary

Usage of smartphones and tablets can enhance the covering of fireball and meteor events and improve the availability of data immediately. Although, the calibrated meteor finder camera network can give more accurate data, but the suggested method expands the covering of events. Quick share of digital data can enlarge the possibility to collect more contemporary meteorites for study or analyze records of fireballs to determine their components. The network can increase easily and relatively at very low cost.

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Invited Lecture

INTEGRATION OF SATELLITE AND GROUND-BASED OBSERVATIONS AND MULTI-DISCIPLINARITY IN EARTHQUAKE AND VOLCANO ERUPTION FORECAST BASED ON THE LAIC PHYSICAL MODEL

Sergey Pulinets[1,2], *Dimitar Ouzounov*[3]

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To provide the forecast of natural processes we should keep in mind that these processes have stohastic (not deterministic) character and, therefore, forecast could be only probabilistic, not deterministic. To get probability of forecast more than 50% we should have in hands the proper instruments, which consist from three components: a) to have adequate measurements uniting the space and ground-based technologies, b) the measured parameters selection should be based on the adequate physical model of the earthquake precursors generation, c) the precursors identification technology should be elaborated to let their selection from the continuous dataflaw. The problem is complicated by the multidisciplinary character of the physical problems to be resolved. The Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) model (Pulinets & Ouzouonov, 2011; Pulinets, Ouzounov, Karelin, & Davidenko, 2015, 2018) is an attempt to fulfill all requirements put by the task of the short-term forecast. The successful results of multi-year monitoring of the short-term precursors of global major earthquakes confirm its validity. On the way of the model development the different attempts were made to select the optimal set of parameters used in multiparameter monitoring (Ouzounov, Pulinets, Hattori, & Taylor, 2018) what permitted to elaborate our approach to the short-term forecast (Pulinets & Ouzounov, 2018).

Two main branches of the model (thermal and ionospheric) were tested by ground-based and satellite technologies and thie will be demonstrated by examples of monitoring of several major earthquakes. It was establisehd that some thermal precursors are able to detect the process of preparation of volcano eruptions what enriches the number of applications for the LAIC model. Generally, the model is able to describe the development of all processes following the event of strong ionization of atmosphere by any source of ionization, for example, radioactive pollution. Similarly, the ionospheric technology is able to detect any cases of strong variations of air conductivity such as dust storms or volcanic ash ejection.

Acknowledgements

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Invited Lecture

THE INFREP VLF/LF RADIO NETWORK FOR STUDYING EARTHQUAKE PRECURSORS: PRESENT SITUATION AND RECENT RESULTS

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The INFREP network is currently consisted of nine receivers located as follows: two in Italy, Romania and Greece; one in Austria, Portugal and Cyprus. The radio receivers were manufactured by an Italian factory and measure the intensity of 10 radio signals in the bands VLF and LF, with 1 minute sampling rate. The signals radiated by VLF-LF broadcasting stations located in Europe are used. The data collected are transmitted every day to the server located at the Department of Physics of the University of Bari (Italy) that is the central node of the network. Generally, due to the different conditions of the ionosphere, the VLF/LF radio signals are less disturbed during the night than during the day. So, the analysis of the radio data generally is performed only on the night-time data. Different methods of analysis for discovering anomalies are used by the scientists. In INFREP cooperation the Wavelet spectra are used. Using the "Morlet function" the Wavelet transform of a time signal is a complex series that can be usefully represented by its square amplitude considering the so-called Wavelet power spectrum. The power spectrum is a two dimensions plot that, once properly normalized with respect to the power of the white noise, gives information on the strength and precise time of occurrence of the various Fourier components which are present in the original time series. Generally, colour from blue to red indicates increase in the power strength; so, red zones define anomalies.

In order to discover anomalies, a software able to apply the Wavelet analysis on the radio data automatically at the end of each day was implemented. The analysis is performed on those 15 days or 20 days preceding each day. Two recent results will be presented.

a) October 2016, Central Italy (Mw=6.5)

At the time of the earthquake, because of a reorganization of the network, among the data collected by the receivers where the online Wavelet analysis is performed only those from CIP (Cyprus) receiver are available. Starting several days before the earthquake two anomalies appeared one after the other in the two VLF signals, the night time intensity of which is analyzed online. The two signals are radiated by DHO (Germany) transmitter (23.4 kHz) and by ICV (Sardinia, Italy) transmitter (20.27 kHz).

b) July-August 2017, Turkey (Mw= 6.7-5.0)

On July 20, 2017 a strong (M_w=6.7) earthquake occurred offshore, near the coast of Turkey and Kos island (Greece); on August 8 an earthquake with M_w=5.0 occurred practically in the same zone. The epicentres are inside the "sensitive" area of the INFREP network. In this case the online Wavelet power spectra of four radio-signals for each one of the CIP (Cyprus), CRE (Crete), GRE (Greece) and IT-Aq (Central Italy) receivers are available. In both the cases anomalies were revealed in DHO

(Germany) signal collected by the CIP receiver. The multi-receivers and multi-signals analysis has permitted to validate the previous pre-seismic anomalies.

The importance of using the previous multi analysis in the research on earthquakes precursors appears in the following further result. On November 7 an earthquake with M_w =5.1 occurred offshore about 120 km far, on south-east direction, from the previous ones. The focal depth was 70 km. Again the epicenter is inside the "sensitive" area of the INFREP network. Also in this occasion anomalies appeared before the earthquake occurrence. But the multi-receivers and multi-signals analysis in this case has permitted to relate these anomalies with meteorological disturbances instead of the earthquake.

Invited Lecture

WORK WITHIN THE COST ACTION ELECTRONET ON THE COUPLING OF THE ATMOSPHERIC ELECTRIC CIRCUIT TO EARTHQUAKES, LIGHTNING AND THE SUN-EARTH ENVIRONMENT

Konstantinos Kourtidis[1], Veronika Barta[2], Jozsef Bor[2], Evgeny Mareev[3], Christina Oikonomou[4], Colin Price[5], Sergey Pulinets[6]

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The global electric circuit (GEC) extends from the surface of the Earth to the lower ionospheric layers. There are feedbacks between GEC and various constituents of the Earth-atmosphere system including aerosols/clouds, lower atmospheric turbulence, lightning, ionisation, earthquakes, and processes arising from the coupling between the Sun and the Earth. To overcome the low level of interaction of research efforts in these discrete fields, the ELECTRONET COST Action aims to enhance interdisciplinary approaches by integrating existing resources in the field of atmospheric electricity and in connecting fields of science. We present here ongoing work within ELECTRONET on the coupling of the atmospheric electric circuit to earthquakes, lightning and the sun-earth environment. We review lightning interactions with climate, aerosols and the lower ionospheric layers and discuss charge transfer between different atmospheric layers. We present Lithosphere-Atmosphere-Ionosphere coupling model to explain possible earthquake precursor signals in ionospheric electron density, atmospheric electricity and radon. We discuss potential approaches to connect interplanetary magnetic field space forcing and surface meteorology through the atmospheric electric field in coupled climate models through cloud droplet microphysics or changes of the cloud droplet radius over the polar regions.

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Invited Lecture

RADAR INTERFEROMETRY AS A NEW TOOL FOR EARTHQUAKE GEOTECHNICAL ENGINEERING

Giovanni Nico[1], *Weike Feng*[2], *Olimpia Masci*[3], *Motoyuki Sato*[4], *Luciano Garramone*[5]

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In this work, we present examples of monitoring of stability of natural slopes, dams, harbour structures, buildings and containing walls and the study of dynamic behaviour of bridges, towers and industrial infrastructures obtained by merging radar interferometry and the traditional geotechnical techniques (Di Pasquale, Nico, Pitullo, & Prezioso 2018; Nico et al., 2018). The aim of the work is to demonstrate the perspective applicability of radar interferometry in earthquake geotechnical engineering practices with emphasis on the merging of radar data with measurements provided by traditional geotechnical techniques and the comparison with numerical results provided by Finite Element Models codes. We describe methodologies to extract information on the stability and dynamic response of different natural and man-made structures that are useful for their seismic assessment.

The novelty of this work consists in new methodologies that have been developed for the radar data acquisition and visualization of results. In particular, new visualization tools have been developed to facilitate an in-depth analysis of displacement and vibration frequency measurements and to identify specific targets on the dam. Radar data have been collected using both Synthetic Aperture Radar (SAR) and Real Aperture Radar (RAR) acquisition modes. As the goal of this paper is to demonstrate that a ground-based radar can provide useful information to the sophisticated analysis tools needed for earthquake analysis, different acquisition strategies have been adapted to measure the dam displacements with simultaneous downstream and upstream radar measurements and specific data acquisition schemes for estimating different components of the displacement vector.

Examples of application of the proposed methodologies to the monitoring of concrete and metallic bridges, bell towers and churches, concrete and earthfill dams will be shown.

We also discuss future perspectives of radar interferometry using new platforms as airships and bistatic configurations which could foster new applications of this technique to the monitoring of natural slopes and man-made structures (Feng, Nico, & Sato, 2019).

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Invited Lecture

CORRELATION OF SOLAR WIND PARAMETERS WITH COSMIC RAYS OBSERVED WITH GROUND STATION

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Solar activity and conditions in heliosphere can be a critical driver of human impact space weather as they can damage electronics and threaten the lives of astronauts as well as increase radiation hazards to high-altitude, high-latitude aviation. It has been well known for more than half a century that solar activity has a strong influence of cosmic ray flux reaching to the Earth (anti-correlation).Solar wind, by both particle drift patterns and structures is responsible for galactic cosmic ray flux modulation, hence the flux of observed galactic cosmic rays varies (GCR) with the solar wind reflecting the solar activity so one could use cosmic ray flux measured at the surface of the earth and in space to monitor the space weather and solar activity. Drops of a few percent in near-Earth GCR flux (Forbush decreases) are well known to be associated with the near-Earth passage of solar wind structures resulting from corotating interaction regions (CIRs) and transient coronal mass ejections (CMEs). We investigated how FDs vary with the properties of the driving solar wind structure. In this context, we study correlations between galactic cosmic rays (GCR) and particles of different species and energies of the solar wind based on the analyses of observational data from our muon detector, worldwide network of neutron detectors and satellites. We perform comparative analysis of Forbush events during Solar cycle 24, which happens during *STEREO* era, enabling in situ and remote observations of solar wind particles' flux from three well-separated heliospheric locations.

Invited Lecture

THE CHALLENGES OF HYPERVELOCITY MICROPHYSICS RESEARCH IN METEOROID IMPACTS INTO THE ATMOSPHERE

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Meteoroid flight through a planetary atmosphere is a hypervelocity collision spread over tens of kilometres of flight. The collision is visible from the distance as meteors thanks to the glowing of shock front or traced by radars thanks to the interaction between radio waves and meteor plasma. These impacts are delivering large amounts of cosmic material into the planetary atmospheres on a daily basis, with occasional larger impacts that penetrate into the lower layers of the atmosphere or even deposits meteorites to the ground. Hence, meteors influence the atmosphere in significant ways and they also give us some important information about the Solar System properties and evolution.

However, despite a large volume of research into this phenomenon, our understanding of the microphysics of meteor flight and its interaction with the surrounding atmosphere is rather sketchy. The velocities and the specific kinetic energies involved are so high that it is largely beyond the realm of laboratory research. High-resolution (spatial and temporal) observation of an individual meteor is difficult due to the meteor's random appearance (on the sky and in time) and large angular size. A single meteor can consist of three or four different flow regimes, depending on the density of surrounding atmosphere, which means different microphysical processes dominating the plasma generation and behaviour. These are reasons why the current models of microphysics of meteor plasma are largely based on theoretical assumptions, extrapolations from studies of hypervelocity flights at lower speeds and data collected by limited observational techniques. Even advanced numerical models are rare and lack the complexity expected from the kinetic energies involved in the meteor flight.

As the observational techniques and sensors have being improving over the last couple of decades, this situation is starting to change. The first sign that our limited knowledge of meteor microphysics cannot keep up with the ever increasing complexity of collected data is visible in the list of unexplained meteor related phenomena. In this work we describe such observations that are considered peculiar and why they imply the need for new concepts in the meteor plasma physics. As an example of this, we will describe a new theory of electrically charged meteors and how the Earth's magnetic field might play role in this process. We will also describe how impact scenarios can be classified based on the parametrisation of meteoroid flight properties.

A new element in the meteor research are the current and upcoming large astronomical sky surveys, from visual to radio wavelengths. It turns out that such surveys are ideal for exploring meteors. We will show how an image of resolved meteor taken by the Sloan Digital Sky Survey

might tell us something about the turbulent meteor wake. The upcoming LSST survey telescope will be even better instrument for meteor detection, while large radar installations for studying the ionosphere and large sky surveys in radio wavelengths will probe the meteor plasma directly. In general, the meteor science is entering a new era dominated by Big Data challenges that require a multidisciplinary approach and a close collaboration between theory and observations. This is a stage for a new generation of meteor researchers (Vinković et al., 2016), who need to be strong in data science combined with the knowledge of plasma physics.

Acknowledgements

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Invited Lecture

THE IMPORTANCE OF GROUND-BASED AND SATELLITE OBSERVATIONS FOR MONITORING AND ESTIMATION OF UV RADIATION IN NOVI SAD, SERBIA

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Solar ultraviolet (UV) radiation is a significant health hazard in the warm part of the year. In order to assess the level of hazard and the effects of UV radiation on the living world, long-term measured or estimated data are needed. In Novi Sad measurement of UV radiation has been performing since 2003, while ozone measurements are made since 2007. However, those data sets are too short for assessing long-term biological effects. Therefore, several techniques for reconstruction of UV radiation doses are developed. Reconstruction techniques were based on using available ground-based measurements of the meteorological data and satellite measurements of total ozone column. It is shown that techniques that use ozone data show better performance than those that use only ground-based meteorological measurements. However, the difference between the performances of the methods is smaller when it comes to the monthly values, indicating that the techniques which use only ground-based meteorological measurements are roughly as good as the ozone-based techniques for assessing long-term changes in the surface UV radiation. The statistical significant increasing long term-trend of annual mean erythemal UV doses (ERY) and the decreasing trend in total ozone column in Novi Sad since 1981 have been noticed. An increase in ERY was noticed in all seasons except in autumn and it was the highest in winter. The analysis showed that the increase in the ERY in the period 1981-1996 is mainly caused by the total ozone column, while the increase after 1996 is largely caused by cloudiness.

Invited Lecture

DEEP LEARNING LSTM RECURRENT NEURAL NETWORK FOR CONSEQUENCE FORECASTING OF THE SOLAR WIND DISTURBANCE

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This research is devoted to determinate the causal relationship between the flow of particles that are coming from the Sun and the different nature disasters like hurricanes Irma, Jose, and Katia. In order to accomplish that, lag correlation analysis was conducted. High correlation coefficients confirmed preliminary conclusion about the relationship between solar activities and hurricane phenomenon, which allowed further research. Five parameters i.e. characteristics of solar activity (Radio Flux 10.7, the flows of protons and electrons with maximum energy, speed and density of solar wind particles) were chosen as input, while wind speed and air pressure of Irma, Jose, and Katia hurricanes were used as output. Input data were sampled to six hours interval in order to adapt time interval to the observed data about hurricanes, in the period between 28 September and 21 December 2017. As a result of the preliminary analysis, using 12,274,264 linear models by parallel calculations, the six of them were chosen as best. The identified lags were the basis for refinement of models with the artificial neural networks. Multilayer perceptrons combine with back propagation and with Long Short-Term Memory (LSTM) recurrent neural networks have been chosen as data analysis models (Fig 1.).

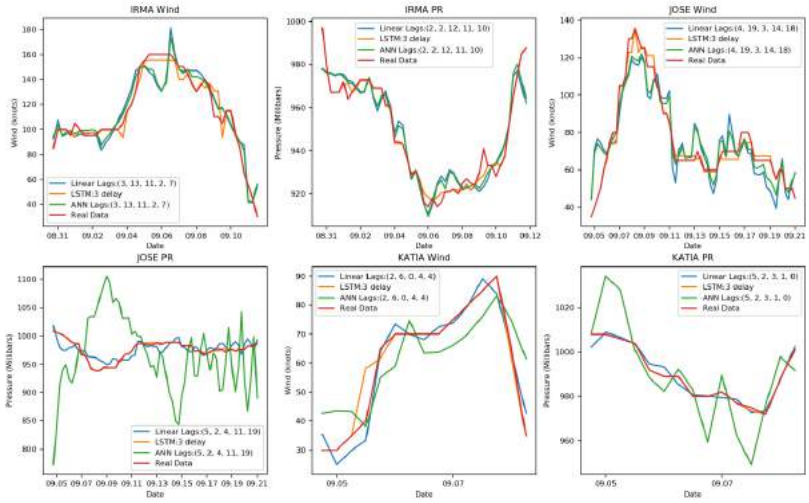

Figure 1. Results of hurricane forecasting with linear models and artificial neural networks for: (a) Wind speed of the Irma hurricane, (b) Pressure of the Irma hurricane, (c) Wind speed of the Jose hurricane, (d) Pressure of the Jose hurricane, (e) Wind speed of the Katia hurricane, (f) Pressure of the Katia hurricane

Comparison of the accuracy of both linear and artificial neural networks results confirmed the adequacy of these models. Sensitivity analysis has shown that Radio Flux 10.7 has the greatest impact on wind speed of the hurricanes. Despite low sensitivity of pressure to change the parameters of solar wind, their strong fluctuations can cause a sharp decrease in pressure, and therefore the appearance of hurricanes.

Invited Lecture

MILUTIN MILANKOVIĆ AND CLIMATE CHANGES LEADING TO ICE AGES

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Milutin Milanković (Dalj, May 28, 1879 - Belgrade, December 12, 1958) went down in the history of science as the man who explained the phenomenon of Ice Ages by astronomical reasons. Milanković elucidated also the history of the Earth's climate as well as that of other planets, being in addition the author of the mathematical theory of climate and of the Earth's pole motion. The most important Milanković's work is "Kanon der Erdbestrahlung und seine Anwendung auf das Eiszaitenproblem" (The Cannon of the Earth's Insolation and its Application to the Ice Ages Problem). It is his capital scientific work, a monograph, comprising results of his researches previously published in 28 research works. In this monograph these results are assembled in one whole, together with new analyses and supplements, including numerous examples and applications of his theory. In this capital work Milankovic presents mathematical theory of Earth's climate (applicable also to other planets), explaining the origin of the Ice Ages and exposing his theory of the Earth's poles motion.

Milanković also did important contributions to the Celestial Mechanics and the History of Astronomy and was a great popularizator of science. At the Ortodox Church Council in 1923 in Istanbul, he submitted the proposal concerning the reform of the calendar, providing for a more exact calendar than the Gregorian one. This proposal was accepted by Council and now is in use in a number of Orthodox churches.

He is one of the most distinguished Serbian scientists, which name have a crater on the far side of the Moon, a crater on Mars and asteroid 1605 Milanković. We note as well that in 2019 we celebrate 140 years from his birth. In this contribution we review his theory of ice ages and discuss climate changes leading to a future ice age on the Earth.

Invited Lecture

DIGITAL AND NUMERICAL METHODS IN ESTIMATION OF A HAZARD FLOODS IN THE MUNICIPALITY OF OBRENOVAC

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The town of Obrenovac is situated near the banks of three rivers, the Sava River, the Kolubara River and the Tamnava River. These rivers present always a real treat for citizens of the city. In the last hazardous flood in 2014, 80 % of the population was in danger. Today's needs in terms of spatial planning, envisaging projects and keeping track of a different kind of information on space demand that new technologies be applied since they make it possible for procuring efficient and reliable information as well as connecting and interconnecting various sorts of data. With advanced numerical methods and GIS data, we have successfully calculated the consequence of the last big flood in 2014. This paper tries to find a connection between hazard and prevention of future hazards.

ABSTRACTS OF PROGRESS REPORTS

Progress Report

NATURAL DISASTERS AND LOW IONOSPHERIC DISTURBANCES DETECTED BY BELGRADE VLF/LF RECEIVER STATION

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In this study we give a review of research on the low ionospheric disturbances in time periods around natural disasters based on data obtained from observations by very low/low frequency (VLF/LF) radio signals recorded by the Belgrade receiver station. These investigations provide new procedures for 1) data mining important for detection of ionospheric disturbances induced by different perturbers, 2) modeling different D-region parameters under perturbed conditions. Here we present the research related to earthquakes, tropical cyclones, and high-energy radiation coming from the Sun and the outher space.

First, we present the current research of the VLF signal variations in time periods around four earthquakes of magnitudes larger than four which occured in Serbia between Oct. 7 and Nov. 4, 2010. Analyses of three VLF signals emitted in Italy (ICV), the UK (GQD) and Germany (DHO) allow us to study locations and possible horizontal motions of ionospheric disturbances. The focus of this study is on the Mw 5.4 earthquake that occurred near Kraljevo on November 3, 2010. The most important preliminary results are detection of clear visible specific changes in the amplitude noise of the VLF signal emitted by the ICV transmitter with the propagation path closest to the earthquake epicenter, and excitations and attenuations of waves within different waveperiod domains. These changes are also detected before the earthquake event which indicates the need for additional research within global investigations of earthquake predictions. Second, we present our statistical study of 41 tropical depressions detected before hurricane appearances over the Atlantic Ocean (Nina et al., 2017). In this analysis we show detection of ionospheric disturbances occurring before, during and immediately after the onset of a tropical depression as registered by the VLF signal emitted from the USA (NAA). Similar to the previous case, this pioneer study opens questions which require additional investigation in global research of tropical cyclone predictions. In this talk we indicate problems in modeling of the local low ionospheric disturbances and point out the importance of integration of different observation techniques and multidisciplinary research including observations, modeling, theoretical analyses, data processing etc. Finally, we show several

studies of the low ionospheric disturbances induced by solar X-ray flares and gamma ray bursts (Nina, Simić, Srećković, & Popović, 2015) and their affects in telecommunication.

In addition to the low ionospheric disturbances which can be connected with different disaster processes we also point out the ionospheric role in monitoring such processes. Namely, the ionosphere is a medium that affects the remote sensing by satellite signals which means that use of this technique to natural disaster observations requires exclusion of ionospheric influences. This could be achieved by using different models, however, their applications can introduce errors in different applications including the Earth observations during intensive local disturbances. Here we present analysis of the perturbed D-region influence on delay in the GNSS and SAR satellite signals (Nina et al., 2019).

Acknowledgements

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Progress Report

THE ROLE OF GALACTIC COSMIC RAYS IN DYNAMICS OF HURRICANES AND TYPHOONS AND GLOBAL CHANGE

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The possible effect of Galactic Cosmic Rays (GCR) on weather and climate is dsicussed for a long time (Pudovkin & Raspopov, 1993; Svensmark, 1998). The correlation of GCR fluxes with global cloudiness was reported by Svensmark and Friis-Christensen, 1997, and later the same authors discussed the role of cluster ions formed as air ionization be GCR (Svensmark, Pedersen, Marsh, Enghoff, & Uggerhøj, 2007). On the shorter time scale the correlation of GCR Forbush decreases and intensification of tropical cyclones in Atlantic was revealed (Pérez-Peraza et al., 2008). Bondur et al. (2008) proposed the physical mechanism of hurricanes intensification by Forbush decreases using Katrina hurricane as example. Now we report the further studies of GCL-hurricanes coupling studying the recent strong events.

Except decadal and short-term effects there are indications of the GCL effects on global change and Earths' climate variations on millennial timescale (Shaviv, 2002). According to this conception, the GCR intensity was modulated by the matter density of the Galactic spiral arms where the Solar system periodically entered (Fig. 1).

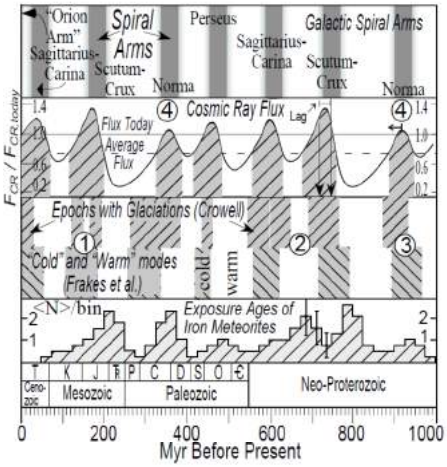

Figure 1. From top to bottom: Galactic spiral arms. GCR flux, climaric epochs, exposure ages of iron meteorites

All these problems are discussed from the common understanding of the themrl effect of ionization in atmosphere.

Acknowledgements

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Progress Report

ANALYSIS OF BIG DATA IN GEOMAGNETISM VIA WAVELET ANALYSIS

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We will extend upon a research devoted to a Wavelet analysis of Big Data in Solar Terrestrial Physics. In order to explain and predict the dynamics of the geomagnetic phenomena we analyze high frequency time series data from different sources: 1. The Interplanetary Magnetic Field (from the ACE satellite). 2. The Ionospheric parameters - TEC (from ionospheric sounding stations). 3. The ground Geomagnetic data (from ground geomagnetic observatories, located in middle geographic latitudes).

We seek for correlations in the wavelet coefficients which would explain the dynamics of different magnetic phenomena in the Solar Terrestrial Physics. The large variety of data used in our research from both Solar Astronomy and Earth Observations makes it a contribution to the newly developing area of AstroGeoInformatics.

The full publication is supposed to appear in a special volume on AstroGeoInformatics at Elsevier, which is under preparation, resulting from the COST action BigSkyEarth within Horizon 2020.

Acknowledgements

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Progress Report

DYNAMICAL ORIGIN OF TWO POTENTIALLY HAZARDOUS ASTEROIDS

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By definition, potentially hazardous asteroids (PHAs) are asteroids that approach Earth nearer than 0.05AU (about 7.5 million km) and have an absolute magnitude (H) less than 22. Today we know for almost 2000 PHAs, but none of them is labeled as a real threat in the next 100 years. In this work, we focus on two asteroids from the PHA list: the (3200) Phaethon, parent body of the Geminides meteor shower and (101955) Bennu, the target of the space mission Osiris-Rex. Using sophisticated numerical methods we search for their dynamical origin in the far outer belt. i.e. we search for escape routes acting via the 5:2 mean motion resonance with Jupiter that may have brought this two asteroids in the close neighborhood of Earth.

Acknowledgements

This research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, under the project 176011 'Dynamics and kinematics of celestial bodies and systems'. The calculations were performed on a Fermi cluster located at the Astronomical Observatory of Belgrade, purchased by the project III44002 'Astroinformatics: Application of IT in astronomy and close fields'.

Progress Report

PLANETARY ATMOSPHERES EROSION DUE TO Sgr A AND (z<0.5) ACTIVE GALACTIC NUCLEI RADIATION

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Evolution of planetary atmospheres due to their host stars's radiation has been investigated for long time. Only recently, erosion of planetary atmospheres due to the radiation of the galactic central engines came to focus, but on theoretical level.

For the first time, we calculated the expected planetary atmospheres mass loss for Earth and for 54 known exoplanets, of which are 16 hot Jupiters residing in the the Milky Way bulge and 38 Earth-like planets due to radiation of the Milky Way Galaxy's central suprmassive black hole -Sagittarius A* (Sgr A*), and the 33 350 active galactic nuclei, at z< 0.5 from the Sloan Digital Sky Survey database (Wislocka, Kovačević, & Balbi, 2019).

Acknowledgements

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Progress Report

STARDUST-RELOADED: THE ASTEROID AND SPACE DEBRIS NETWORK

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The Stardust Reloaded project is a four year pan-European research project founded by the European Union H2020 programme. The project will investigate how to explore and exploit asteroids and sustainability in space. In the case of asteroids, the Stardust Reloaded project is expected to specifically increase scientific knowledge on the shape, gravity, composition and dynamics of asteroids, in view of possible actions to prevent a catastrophic impact with the Earth. Besides, this project will investigate how mineral resources on these celestial objects could be exploited to enhance our exploration of the Solar System. The project also intends to investigate the safe management of increasing space traffic to prevent collisions and achieve sustainability in space. A number of people launching satellites has been increasing, particularly smaller and smaller ones, making the risk of collision, and the risk of setting off a cascade, larger and larger. The Stardust Reloaded project aims to understand how the growth in satellites orbiting Earth affects the evolution of the space environment and how we can best manage that. The Stardust Reloaded study comprises 20 partners including the European, French and German space agencies and will help to fund 15 early-stage career researchers. The goal of Stardust-Reloaded is to conduct cutting edge research by training young researchers with skills that go far above the norm, ranging from entrepreneurial to regulatory, looking forward with leadership skills for their futures and developing educational platforms for the even younger generations to come.

ABSTRACTS OF POSTERS

Poster

NEO DETECTION USING COMPLEX EVENT PROCESSING

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Complex Event Processing (CEP) concepts and technologies, proven in industries that demand high throughput of data and quick decision-making, can be tailored for astronomical data streams. Already tested on LSST simulated data, currently being adapting to ZTF (Bellm, 2014) data archive and hopefully ready for full-blown LSST alert stream (Juric, Axelrod, & Becker, 2013), CEP-based software offer scalable filtering and temporal inference mechanisms over real-time astronomical data.

CEP can be used for a variety of things from observatory monitoring system to classification via pattern matching (Vujčić, Aleksić, Nešković, & Jevremović, 2017), and can as well be used for NEO candidate selection, especially in dual exposure surveys such as LSST.

Acknowledgements

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Poster

ATMOSPHERIC DISTURBANCES DUE TO SEVERE STORMY WEATHER

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Severe stormy weather during the night of 27^{th}-28^{th} of May, 2009 over Balkan peninsula caused intense atmospheric disturbances. Strong release of energy by atmospheric lightning discharges induced ionization changes along the propagation path of Very Low Frequency radio signals (VLF) of NAA/24.0 kHz, GQD/22.1 kHz and DHO/23.4 kHz signal traces transmitted from USA, UK and Germany, respectively, and received by Absolute Phase and Amplitude Logger (AbsPAL) system located in Belgrade (44.85^{o} N, 20.38^{o} E). Increased ionization is apparent in the perturbation of the VLF signal amplitude and phase delay with respect to regular undisturbed ionospheric conditions. The survey enclosed data from three independent sources: 1) VLF signal records from Belgrade Institute for Physics database, 2) video records of sprite events from ITALIAN METEOR and TLE NETWORK (I.M.T.N.) database and 3) detected lightning strokes from European Cooperation for Lightning Detection (EUCLID) network database for area 40^{o} N – 48^{o} N and 10^{o} E – 23^{o} E, and was carried out in order to find coincidence and possible relationship between these three phenomena during the stormy night of 27^{th}-28^{th} of May, 2009. In the presented analysis, VLF signal amplitude and phase delay data were used as the basic data set related to two other datasets. The VLF perturbations on NAA/24.0 kHz, GQD/22.1 kHz and DHO/23.4 kHz traces related to the same atmospheric discharge were of different type and magnitude. In most cases, the correspondence between VLF perturbations and CG strokes and on the other hand, VLF perturbations and TLE events, was found. In some cases the correspondence between all three phenomena was found.

Acknowledgements

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Poster

RADON AS POTENTIAL EARTHQUAKE PRECURSOR

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Radon-222 (^{222}Rn) is naturally occurring radioactive gas with an half life ($t_{1/2}$) of 3.8 days (Tomer, 2016), ubiquitous in air, soil and groundwater/springs. Radon-222 is formed within solid mineral grains by the radioactive decay of radium-226, in the uranium-238 decay chain: $^{238}U \rightarrow ^{226}Ra \rightarrow ^{222}Rn$ (Kardos et al. 2015). Radon atoms can escape from the mineral grains into the pore space between grains (Rn emanation), from where they can migrate by diffusion and/or convection/advection (Rn transport), and finally exhale into the atmosphere (Rn exhalation) (Fig. 1) (Barbosa, Donner, & Steinitz, 2015; Kardos et al. 2015). Over the years potential earthquake precursors including radon have been reported (Barman, Ghose, Sinha, & Deb, 2016; Ghosh, Deb, & Sengupta, 2009; Planinić, Radolić, & Vuković, 2004). The main rationale for this is the occurrence of radon anomalies observed before an earthquake. As accurate earthquake prediction is still a challenging problem, studies on radon as potential earthquake precursor are in progress worldwide.

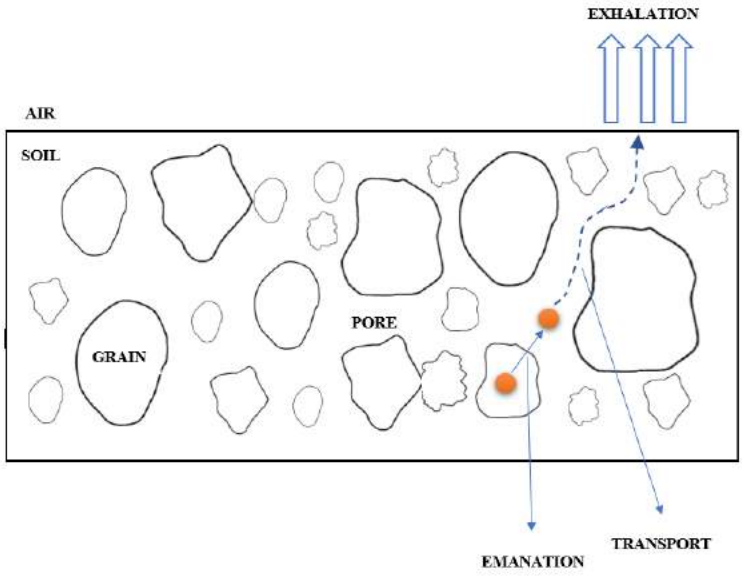

Figure 1. The release of radon into the air.

Acknowledgements

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Poster

CONSTRAINING YUKAWA GRAVITY FROM PLANETARY MOTION IN THE SOLAR SYSTEM

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Here we use the observed additional perihelion precession in the Solar System, obtained from observations of planets and spacecrafts, to study the possible existence of Yukawa correction term to the Newtonian gravitational potential. Our study was motivated by previous analyses which indicated the possible discrepancies from Newtonian gravity in this form and at wide range of astrophysical scales (Adelberger, Gundlach, Heckel, Hoedl, & Schlamminger, 2009; Borka, Jovanović, Borka Jovanović, & Zakharov, 2013; Zakharov, Jovanović, Borka, & Borka Jovanović, 2016, 2018). Yukawa gravity was introduced to cure some shortcomings of General Relativity at galactic and extragalactic scales. We demonstrated that this form of gravity can give the values for orbital precession which are in better agreement with observations than the corresponding predictions of General Relativity. The obtained results can be used for setting stronger constrains on variation of the gravitational constant G, as well as on the fundamental constant δ of Yukawa gravity. Therefore, Yukawa gravity could be used to improve the results for motion of planets, other Solar System bodies, as well as spacecrafts, and as a consequence, it can help us to get more reliable predictions for natural hazards in the Solar System.

Acknowledgments

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Poster

ELECTRON-IMPACT CROSS SECTIONS FOR THOLINS: COVERAGE WITHIN BEAMDB DATABASE

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Name *Thiolin* has been coined by Sagan and Kare (1976) in order to represent a number of complex organic molecules and polymers that are formed in mixtures of gases with verious hydrocarbons and compounds with nitrogen and sulphor, which at the end in the interactions with UV ligth and discharges are composing the redish and hazy aerosols in the atmospheres of Solar System planets and moons. These kinds of molecules have been observed for example by The Cassini Mission in Titan athmosphere (Dubois et al., 2019; Hörst, 2017) or by The Rosetta Mission in comet 67P/Churyumov-Gerasimenko (Marinković, Bredehöft, Vujčić, Jevremović, & Mason, 2017; Pommerol et al., 2015).

Here, we concentrate on the coverage of ionization cross sections for molecular ions in BEAMDB database and thier importance in analyses of satellite and ground-based observations, as well as multi-disciplinarity in research and prediction of different models of atmospheric phenomena in Solar system. BEAMDB database is hosted at the Serbian Virtual Observatory and is devoted to electron collisional processes. It maintains cross sections (differential, integral, toatal) and electron spectroscopical data such as electron energy loss spectra and threshold spectra (Marinković et al., 2019). The examples of ionization cross sections are those published for $C_2H_2^+$ (see Fig. 1) and $C_2D_2^+$ ions (Cherkani-Hassani et al., 2010) and for OH^+ and OD^+ ions (Belić et al., 2012).

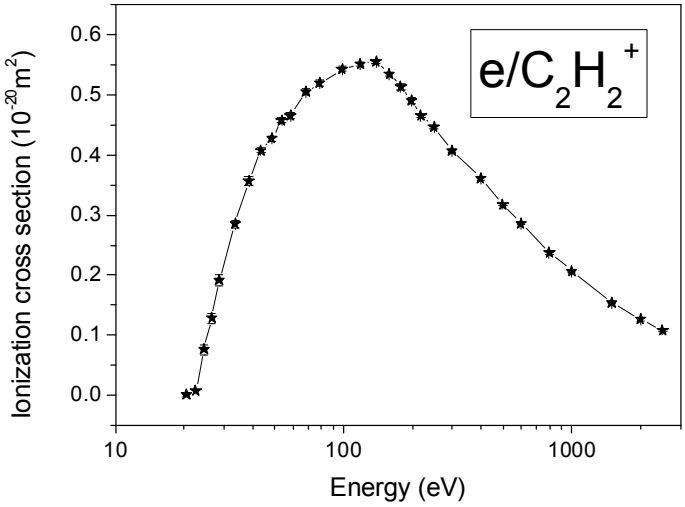

Figure 1. Electron-impact single ionization cross section for $C_2H_2^+$ ions (Cherkani-Hassani et al., 2010)

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Poster

EXTREME SOLAR RADIATION AND NATURAL DISASTERS: CROSS DISCIPLINARY APPROACHES

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The investigation of extreme solar radiation and connections with natural disasters is a very complicated task. It is of key importance to explore and research the connections between this extreme activity and natural disasters, and develop ways to prevent, prepare and respond to them. These studies and research require cross disciplinary approaches i.e. cooperation of experts within various fields of science (Srećković & Nina 2019; Nina, Srećković, & Radovanović, 2019). For this reason, it is of crucial importance to provide opportunities for collaboration in this field of research (Srećković, Šulić, Vujčić, Jevremović, & Vyklyuk, 2017).

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Poster

SOLAR ACTIVITY, NATURAL HAZARDS, LOW IONOSPHERIC PERTURBATIONS AND SATELLITE AND GROUND-BASED OBSERVATIONS

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The monitoring of the terrestrial lower ionosphere layers by the mean of the radio technique can play an important role for a better understanding of Space Weather conditions and natural disasters (Srećković, Šulić, Vujčić, Jevremović, & Vyklyuk, 2017). It is stated that the plasma in the atmospheric D-region is a very sensitive medium to external forcing like stellar explosive radiation, energetic particle intrusion, etc. The intense solar radiation can create sudden ionospheric disturbances (SIDs) and further cause telecommunication interferences/blackouts as well as natural disasters e.g. forest fires (Srećković & Nina 2019; Nina, Srećković, & Radovanović, 2019). Some scientists think that in certain cases fires are connected with the activity of the Sun i.e the solar wind (SW) charged particles. The focus of this contribution is on the study of electron density enhancement induced by solar X-ray radiation. The model computation is applied to determine the perturbation structures in the terrestrial D-region, during occurrences of explosive solar events. It can be concluded that these events lead to an increased rate of electrons production and electron density can increase depending on flare intensity. The results confirmed the successful use of applied technique for detecting space weather phenomena such as solar explosive events as well for describing and modeling the ionospheric electron density which are important as the part of electric terrestrial-conductor environment through which external-SW electrons can pass and cause natural disasters on the ground like fires.

Acknowledgements

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Poster

COMPARISON OF MODIS AEROSOL OBSERVATIONS AND GROUND-BASED PM MEASUREMENT FOR THE BELGRADE REGION

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Suspended particulate matter in the atmosphere, commonly known as atmospheric aerosol, plays one of the most important role in climate changes and environmental issues. Numerous epidemiological studies in recent years have shown detrimental effects of aerosol pollution on human health, causing respiratory and cardiovascular disease and even premature death (Kim, Oh, Park, & Cheong, 2018). Additionally, scattering and absorption of solar and terrestrial radiation as direct, and modification of cloud condensation nuclei through aerosol-cloud interaction as indirect effects of aerosols, make the largest contribution to the total uncertainty of the radiative forcing (Intergovernmental Panel on Climate Change, 2007).

Assessment of air quality primarily relies on ground-based measurements of the concentrations of airborne particulate matter (PM) with aerodynamic diameter less than 10 μm (PM_{10}) and 2.5 μm ($PM_{2.5}$), and for this purpose, all European countries were established regulatory monitoring networks. Because this kind of observation provides limited spatial PM information, various studies have been conducted to obtain PM estimates from satellite measurements (Kumar, Chu, & Foster, 2007; Li, Carlson, & Lacis, 2015). Aerosol optical depth (AOD) is one of the most important aerosol product retrieved from satellite measurements, and represent the attenuation of solar radiation caused by aerosols. The relationship between AOD (integration of the aerosol extinction coefficient from the Earth's surface to the top of the atmosphere) and surface PM concentrations depends on various factors: aerosol type and its chemical composition, vertical distribution, spatial and temporal variability - all governed by emissions and meteorological conditions (Kong, Xin, Zhang, & Wang, 2016; Sayer, Hsu, Bettenhausen, & Jeong, 2013).

In this study, we investigated the relationship between AOD and, $PM_{2.5}$ and PM_{10} concentrations data set from the Belgrade region. We obtained Level 2 AOD data at 0.55 μm based on measurements by Moderate Resolution Imaging Spectroradiometer (MODIS) aboard *Terra* (MOD04) and *Aqua (*MYD04) platforms with the resolution of 10x10 km^2 for three years period 2012-2014. Hourly average $PM_{2.5}$ and PM_{10} mass concentrations for the investigating period were obtained from urban and suburban monitoring stations of the Institute of Public Health Belgrade. The analyses included the impact of ambient relative humidity (RH) on PM concentration due to the hygroscopic growth of aerosol particles, as well as vertical correction of AOD with respect to the mixing layer height (MLH). The preliminary results showed that AOD retrieved from satellite sensor can be considered as a good proxy for ground observed PM mass concentrations. It is found that the relationship between AOD and PM is practically linear and strongly influenced by RH and MLH. The increase in the correlation coefficient (of around 20%) is indicative for vertical corrected AOD parameter and dry PM. Further investigation should examined influences of the other

meteorological parameters, different season and types of monitoring stations at the examined PM-AOD relationship. Also, the study based on the analyses of satellite aerosol products and ground-based measured pollutants concentrations may be used for air quality assessment and PM prediction in the region of the City of Belgrade.

Acknowledgments

This paper was realized as a part of the projects III43007 and III41011 financed by the Ministry of Education and Science of the Republic of Serbia within the framework of integrated and interdisciplinary research for the period 2011-2019. The MODIS data were obtained from NASA Atmosphere Archive and Distribution System (LAADS) at the Goddard Space Flight Center (GSFC) and we would like to thanks MODIS team for developing the AOD product.

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PROGRAMME

Friday, May 10

13:00 - 15:00 **Arrival, registration and lunch**

Chairs: Aleksandra Nina and Milan Radovanović
15:30 – 15:45 **Opening ceremony**

Chair: Sergey Pulinets
15:45 – 16:30 **Darko Jevremović:** *SOLAR SYSTEM OBJECTS IN THE LSST ERA (ASSESSING THE HAZARDS)*
16:30 – 17:00 **Pál Gábor Vizi, Péter Szutor, Szaniszló Bérczi, Szilárd Csizmadia, Tibor Hegedűs:** *TRAJECTORY AND ANALYSIS OF LOCAL FIREBALL-METEORITE EVENTS AND EXTENDED METEOR HUNTING WITH SMARTPHONES AS 'SKY EVENT' CAMERAS*

18:00 – 19:30 **Welcome cocktail**
20:00 – Dinner time

Saturday, May 11

Chair: Bratislav P. Marinković
9:00 – 9:45 **Sergey Pulinets, Dimitar Ouzounov:** *INTEGRATION OF SATELLITE AND GROUND-BASED OBSERVATIONS AND MULTI-DISCIPLINARITY IN EARTHQUAKE AND VOLCANO ERUPTION FORECAST BASED ON THE LAIC PHYSICAL MODEL*
9:45 – 10:30 **Pier Francesco Biagi:** *THE INFREP VLF/LF RADIO NETWORK: PRESENT SITUATION AND RECENT RESULTS*

10:30 – 11:00 Coffee break

Chair: Pier Francesco Biagi
11:00 – 11:45 **Konstantinos Kourtidis, Veronika Barta, Jozsef Bor, Evgeny Mareev, Christina Oikonomou, Colin Price, Sergey Pulinets:** *WORK WITHIN THE COST ACTION ELECTRONET ON THE COUPLING OF THE ATMOSPHERIC ELECTRIC CIRCUIT TO EARTHQUAKES, LIGHTNING AND THE SUN-EARTH ENVIRONMENT*
11:45 – 12:30 **Aleksandra Nina, Giovanni Nico, Luka Č. Popović, Vladimir M. Čadež, Milan Radovanović:** *NATURAL DISASTERS AND LOW IONOSPHERIC DISTURBANCES DETECTED BY BELGRADE VLF/LF RECEIVER STATION*

Chair: Ognyan Kounchev

12:30 – 14:00 **Discussions – integration of observation methods and models in research of earthquakes and volcanoes**

14:00 – 15:00 Lunch break

Chair: Luka Č. Popović

15:00 – 15:45 **Giovanni Nico, Weike Feng, Olimpia Masci, Motoyuki Sato, Luciano Garramone:** *RADAR INTERFEROMETRY AS A NEW TOOL FOR EARTHQUAKE GEOTECHNICAL ENGINEERING*

15:45 – 16:30 **Nikola Veselinović, Mihailo Savić, Aleksandar Dragić, Dimitrije Maletić, Dejan Joković, Radomir Banjanac, Vladimir Udovičić, David Knežević:** *CORRELATION OF SOLAR WIND PARAMETERS WITH COSMIC RAYS OBSERVED WITH GROUND STATION*

16:30 – 17:00 **Sergey Pulinets:** *THE ROLE OF GALACTIC COSMIC RAYS IN DYNAMICS OF HURRICANES AND TYPHOONS AND GLOBAL CHANGE*

17:00 – 17:30 Coffee break

Chair: Darko Jevremović

17:30 – 18:15 **Dejan Vinković, Maria Gritsevich:** *THE CHALLENGES OF HYPERVELOCITY MICROPHYSICS RESEARCH IN METEOROID IMPACTS INTO THE ATMOSPHERE*

18:15 – 19:00 **Bozhidar Srebrov, Ognyan Kounchev, Georgi Simeonov:** *ANALYSIS OF BIG DATA IN GEOMAGNETISM VIA WAVELET ANALYSIS*

20:00 – **Meeting dinner**

Sunday, May 12

Chair: Konstantinos Kourtidis

9:00 – 9:30 **Slavica Malinović-Milićević, Zoran Mijatović, Ilija Arsenić, Zorica Podrašćanin, Ana Firanj Sremac, Milan Radovanović, Nusret Drešković:** *THE IMPORTANCE OF GROUND-BASED AND SATELLITE OBSERVATIONS FOR MONITORING AND ESTIMATION OF UV RADIATION IN NOVI SAD, SERBIA*

9:30 – 10:00 **Nataša Todorović:** *DYNAMICAL ORIGIN OF TWO POTENTIALLY HAZARDOUS ASTEROIDS*

10:00 – 10:30 Coffee break

Chair: Giovanni Nico

10:30 – 12:00	**Discussions – integration of observation methods and models in research of hurricanes, meteors and climatic changes**
12:00	**Meeting photo**
12:05 – 14:00	**Guided tour of Petnica's vicinity**
14:00 – 15:00	Lunch break

Chair: Milan S. Dimitrijević

15:15 – 16:00	**Yaroslav Vyklyuk, Milan Radovanović, Slavica Malinović-Milićević**: *DEEP LEARNING LSTM RECURRENT NEURAL NETWORK FOR CONSEQUENCE FORECASTING OF THE SOLAR WIND DISTURBANCE*
16:00 – 16:30	**Andjelka B. Kovačević:** *PLANETARY ATMOSPHERES EROSION DUE TO Sgr A AND (z<0.5) ACTIVE GALACTIC NUCLEI RADIATION*
16:30 – 17:00	**Dušan Marčeta, Bojan Novaković:** *STARDUST-RELOADED: THE ASTEROID AND SPACE DEBRIS NETWORK*
17:00 – 17:30	Coffee break
17:30 – 19:00	**Posters**
19:00 –	Dinner time
20:30 –	**Networking event**

Monday, May 13

Chair: Yaroslav Vyklyuk

9:00 – 9:45	**Milan S. Dimitrijević:** *MILUTIN MILANKOVIĆ AND CLIMATE CHANGES LEADING TO ICE AGES*
9:45 – 10:30	**Aleksandar Valjarević, Nikola Bačević, Marko Ivanović:** *DIGITAL AND NUMERICAL METHODS IN ESTIMATION OF A HAZARD FLOODS IN THE MUNICIPALITY OF OBRENOVAC*
10:30 – 10:45	Closing ceremony
11:15 –	Departure

LIST OF POSTERS

P1. Veljko Vujčić, Darko Jevremović: *NEO DETECTION USING COMPLEX EVENT PROCESSING*

P2. Aleksandra Kolarski: *ATMOSPHERIC DISTURBANCES DUE TO SEVERE STORMY WEATHER*

P3. Jelena Petrović, Snežana Dragović: *RADON AS POTENTIAL EARTHQUAKE PRECURSOR*

P4. Predrag Jovanović, Duško Borka, Vesna Borka Jovanović: *CONSTRAINING YUKAWA GRAVITY FROM PLANETARY MOTION IN THE SOLAR SYSTEM*

P5. Bratislav P. Marinković, Stefan Ivanović, Nebojša Uskoković, Milutin Nešić: *ELECTRON-IMPACT CROSS SECTIONS FOR THOLINS: COVERAGE WITHIN BEAMDB DATABASE*

P6. Milan Radovanović, Aleksandra Nina, Vladimir A. Srećković: *EXTREME SOLAR RADIATION AND NATURAL DISASTERS: CROSS DISCIPLINARY APPROACHES*

P7. Vladimir A. Srećković: *SOLAR ACTIVITY, NATURAL HAZARDS, LOW IONOSPHERIC PERTURBATIONS AND SATELLITE AND GROUND-BASED OBSERVATIONS*

P8. Zoran Mijić, Mirjana Perišić: *COMPARISON OF MODIS AEROSOL OBSERVATIONS AND GROUND-BASED PM MEASUREMENT FOR THE BELGRADE REGION*

AUTHORS' INDEX

Ilija Arsenić 23
Nikola Bačević 28
Radomir Banjanac 20
Veronika Barta 17
Szaniszló Bérczi 10
Pier Francesco Biagi 15
Jozsef Bor 17
Duško Borka 45
Vesna Borka Jovanović 45
Vladimir M. Čadež 31
Szilárd Csizmadia 10
Milan S. Dimitrijević 26
Aleksandar Dragić 20
Snežana Dragović 43
Nusret Drešković 23
Weike Feng 18
Ana Firanj Sremac 23
Luciano Garramone 18
Maria Gritsevich 21
Tibor Hegedűs 10
Marko Ivanović 28
Stefan Ivanović 47
Darko Jevremović 9, 41
Dejan Joković 20
Predrag Jovanović 45
David Knežević 20
Aleksandra Kolarski 42
Ognyan Kounchev 35
Konstantinos Kourtidis 17
Andjelka B. Kovačević 37
Dimitrije Maletić 20
Slavica Malinović-Milićević 23, 24
Dušan Marčeta 38
Evgeny Mareev 17
Bratislav P. Marinković 47
Olimpia Masci 18
Zoran Mijatović 23
Zoran Mijić 51
Milutin Nešić 47
Giovanni Nico 18, 31
Aleksandra Nina 31, 49
Bojan Novaković 38
Christina Oikonomou 17
Dimitar Ouzounov 13
Mirjana Perišić 51
Jelena Petrović 43
Zorica Podrašćanin 23
Luka Č. Popović 31
Colin Price 17
Sergey Pulinets 13, 17, 33
Milan Radovanović 23, 24, 31, 49
Motoyuki Sato 18
Mihailo Savić 20
Georgi Simeonov 35
Bozhidar Srebrov 35
Vladimir A. Srećković 49, 50
Péter Szutor 10
Nataša Todorović 36
Vladimir Udovičić 20
Nebojša Uskoković 47
Aleksandar Valjarević 28
Nikola Veselinović 20
Dejan Vinković 21
Pál Gábor Vizi 10
Veljko Vujicić 41
Yaroslav Vyklyuk 24

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