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PROCEEDINGS OF THE 5th INTERNATIONAL CONFERENCE ON RESEARCH, TECHNOLOGY AND EDUCATION OF SPACE

H-SPACE 2019

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organized by Federated Innovation and Knowledge Centre
of Budapest University of Technology and Economics
and Hungarian Astronautical Society

H-SPACE 2019

Edited by László Bacsárdi and Kálmán Kovács

MANT
Magyar Asztronautikai Társaság

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H-SPACE 2019

Proceedings of the
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February 27-28, 2019, Budapest, Hungary
at Budapest University of Technology and Economics

Organized by
Federated Innovation and Knowledge Centre of
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and
Hungarian Astronautical Society

Editors
László Bacsárdi and Kálmán Kovács

MANT 2019

Conference proceedings

H-SPACE 2019

5th International Conference on Research, Technology and Education of Space
February 27-28, 2019, Budapest, Hungary
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WELCOME from the Organizing Committee

Welcome to the 5th edition of our H-SPACE conference series!

We are happy to welcome you at the 5th International Conference on Research, Technology and Education of Space. Special welcome to those participants who join the H-SPACE conference for the first time.

The event is organized by the Federated Innovation and Knowledge Centre (EIT), within the Faculty of Electrical Engineering and Informatics at the Budapest University of Technology and Economics (BME) – in cooperation with the Hungarian Astronautical Society (MANT), which is the oldest space association in Hungary. The organization of the conference series started in 2015, at a time of growing opportunities arising from ESA recently granting membership to Hungary and the need for a joint presentation of space activities pursued at BME. The selection of the date of the event pays tribute to the successful deployment to orbit and mission of the first Hungarian satellite, the Masat-1, which has been launched on February 13, 2012.

This year people all over the world celebrate the greatest "small step for a man", the 50th anniversary of the step of the first men onto the lunar surface. Humanity have explored the possibilities of life on other planets from that time, but from a very long time ago the essential conditions for life on Earth. Regarding to this, topic of this year's conference is "Special focus on water and environment". The agenda of the conference addresses scientific, technological and educational issues of space research and space activities. The conference is open for both local and international professionals and provides an opportunity to showcase Hungarian scientific, technological, educational and outreach activities, related to space.

The Organizing Committee has internationally recognized members: Prof. József Ádám, Dr. Tibor Bálint, Ferenc Horvai, Prof. János Lichtenberger, Dr. Lóránt Földváry, Prof. László Pap, Prof. Gábor Stépán, Dr. Szabolcs Rózsa We are grateful for their contributions to the success of the conference.

The conference will have five main sections: Science and Technology I-III and Education and Outreach I and II from which Science and Technology III and Educatioan and Outreach II will be a poster session with 18 great presentation.

We will celebrate the 5th edition of the H-SPACE conference series with a special poster session which will start right after the keynote presentation, held by Prof. János Józsa, the rector of the Budapest University of Technology and Economics.

The best lectures (oral or poster) will receive the option of publishing in a journal, thus the conference contributes to the scientific progress of the researchers as a publication opportunity.

This book contains the abstracts of the presentations. In the coming months, selected full papers will be published in the official conference proceedings which will be available on our website, space.bme.hu. On this website, the proceedings and selected papers of the previous issues can be found as well.

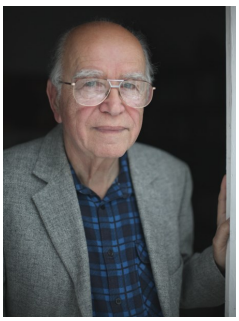
We hope you will enjoy your time in Budapest and the H-SPACE conference could help to learn about new scientific and technological results and strengthen your network.

Kálmán Kovács
co-chair
Director of BME EIT

László Bacsárdi
co-chair
Vice President of MANT

Welcome

Iván Almár
honorary president, Hungarian Astronautical Society
honorary member, International Academy of Astronautics



The featured topic of this year's H-Space conference is „Special focus on water and environment". It is well known that a continuous monitoring of our environment – including the hydrosphere – is a very important task, since it has a decisive influence on the future of life on Earth. The importance of the role of remote sensing satellites was indisputable at least in the past four decades, because they can follow all changes in the environment continuously and globally.

Taking one step further to the investigation of other celestial bodies in the Solar System, we are more and more interested in the alien environment observed on their surfaces by our space probes. Obviously these investigations are focusing on looking for water as probably a necessary condition of life everywhere. Mars, Europa, Enceladus and Titan are the most important targets at present in the Solar System.

Finally we are approaching a possibility to investigate also the surface environments of extrasolar planets not very far from Earth. Water vapor in the spectrum of the atmosphere of an exoplanet might indicate the presence of oceans and life on its surface; environmental peculiarities, on the other hand, can be technosignatures pointing out an advanced technical civilization.

PROGRAM

In this program, the affiliation of the first author is listed.

February 27, Wednesday

Location: Building K, first floor, Saloon room

14:00 Greetings

László Bacsárdi, Vice President of MANT, co-chair of the Organizing Committee

14:05 Discussion:

From Moon landing to Mars landing (in Hungarian)
Participants:
Iván Almár, Honorary President, Hungarian Astronautical Society
András Sik, Vice President, Hungarian Astronautical Society
Moderator:
Előd Both, President, Hungarian Astronautical Society

Session Chair: *Kálmán Kovács*

15:00 Opening ceremony

János Józsa, Rector, Budapest University of Technology and Economics
Orsolya Ferencz, Ministerial Commissioner, Ministry of Foreign Affairs and Trade
Előd Both, President, Hungarian Astronautical Society
Kálmán Kovács, President, BME Space Forum

15:15 Keynote presentation

On the hydrologic Impacts of Climate Change
János Józsa, Rector, Budapest University of Technology and Economics

15:40 One minute madness (Session Science and Technology III and Education and Outreach II)

Poster authors present their work in 1 minute

16:00 Poster session with coffee break

Session Chair*: Lóránt Földváry*

16:45-18:30: Technical presentations – Session Science and Technology I

Radio interferometry for the study of Jupiter's icy moons
Sándor Frey
Konkoly Observatory, MTA Research Centre for Astronomy and Earth Sciences, Hungary

Determination of 3D surface deformation for the 2018 Oaxaca earthquake using INSAR
Gergely László and *Lóránt Földváry*
Institute of Geoinformatics Alba Regia Technical Faculty, Óbudai University, Hungary

ESA perspective on lunar surface exploration
Mátyás Hazadi
European Space Agency, The Netherlands

Satellite Fading Classification with Artificial Intelligence for 5G
Boldizsár Márton and *László Csurgai-Horváth*
Department of Broadband Infocommunications and Electromagnetic Theory, BME, Hungary

Investigation of stochastic disturbances in satellite connected terrestrial millimetre wave wireless mesh network
János Z. Bitó
Department of Broadband Infocommunications and Electromag netic Theory, BME, Hungary

Quantum Tracking a Dataset – a New Application of Quantum Cryptography
Máté Galambos and *László Bacsárdi*
Dennis Gabor College, Hungary

The RADCUBE project and beyond – Cosmic Radiation Monitoring CubeSat mission
Dorottya Milánkovich, Zoltán Kovács, Gábor Marosy and Balázs Zábori
C3S Ltd., Hungary

February 28, 2019, Thursday

Location: Building I, ground floor, IB.026.

9:00 Welcome coffee

Session Chair: *László Csurgai-Horváth*

9:45 Keynote presentation

Recent dosimeter developments for human spaceflight at the Centre for Energy Research, Hungarian Academy of Sciences
Attila Hirn, MTA Centre for Energy Research, Hungary

10:05-11:35 Technical presentations – Session Science and Technology II

UV Spectrophotometric Time Series Analysis of the Herbig Ae Star HD 163296
Gerard M. Williger, *Anna Vankó*, *Péter Ábrahám, Carol A. Grady* and *Ágnes Kóspál*
University of Louisville, KY, USA

Studying the MART tomography approach under severe weather conditions
Yuxiang Yan, Wusheng Hu, Ildikó Juni and *Szabolcs Rózsa*
School of Transportation, Southeast University in China, China

Transmission rates of lightning discharges into whistlers
Dávid Koronczay, *János Lichtenberger* and *Orsolya Ferencz*
Eötvös Loránd University, Hungary

Exploitation of Sentinel-1 SAR data for studying geodynamic, tropospheric and ionospheric processes
István Bozsó, Eszter Szűcs, László Bányai and *Viktor Wesztergom*
Geodetic and Geophysical Institute, MTA Research Centre for Astronomy and Earth Sciences, Hungary

A wide swath of Sentinel-based deformation monitoring applications in Hungary
Péter Farkas, Gyula Grenerczy and *Sándor Frey*
GeoSentinel Ltd., Hungary

Developing Balloon-Borne Payload for Remote Sensing Applications
Zsófia Bodó and *Bence Góczán*
Simonyi Károly College for Advance Studies, BME, Hungary

11:35- 11:50 Break

11:50-11:55: Opening of the Education and Outreach Session

László Jakab, Dean
Faculty of Electrical Engineering and Informatics, BME

11:55-13:40: Technical presentations – Session Education and Outreach

CoderDojo and the emergence of informal space tech education ecosystems
Radu Ticiu, Andrea Magyar and *Virgiliu Pop*
CoderDojo Timisoara, Romania

The Watermill-Project for Secondary Schools
Carmen Adina Oancea and *Otilia Bogdana Lastun*
Colegiul National "Octavian Goga" Sibiu, Romania

Inspiring the Next Generation in the Hungarian Space Camp
Dorottya Milánkovich and *László Bacsárdi*
Hungarian Astronautical Society, Hungary

The technology of CanSats, which can involve secondary school students in space
András Illyés, Levente Dudás and *András Gschwindt*
Budapest University of Technology and Economics, Hungary

The popularization of space exploration amongst high school students
Ténia Kovács, Annamária Komáromi and *Andrea Király*
Eötvös Loránd University, Hungary

The MarsQuake Program for Hungarian High School Students
Márta Kiszely and *György Hudoba*
Geodetic and Geophysical In stitute, MTA Research Centre for Astronomy and Earth Sciences, Hungary

Space weather and Arduino meteo station
Mária Pető
Székely Mikó High School Sf. Gheorghe, Romania

13:40 Closing remarks

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Building the First Hungarian Free-space Quantum Communication Device
Máté Galambos, Lászlo Bacsárdi, Zoltán Belső, Eszter Gerhátné Udvary, Győző Gódor, Sándor Imre, Zsolt Kis, István Koller, János Kornis, Zsolt Papp and *Viktor Zsolczai*
Budapest University of Technology and Economics, Hungary

Detection of Tsunamis based on Ionospheric Satellite Signals
Gergely Mindler, Márk György Fék and Bence Szendi
Hungary

Educational Aspects of Developing a High Altitude Balloon Platform
Zsófia Bodó and *Bence Góczán* Simonyi Károly
College for Advance Studies, BME, Hungary

Estimating 3D Rain Fields with Satellite Beacon Measurements
Bernard Adjei-Frimpong and *László Csurgai-Horváth*
Department of Broadband Infocommunications and Electromag netic Theory, BME, Hungary

Evaluation of plasma properties from ground measurements for radiation belts modeling
Lilla Juhász, Yoshiharu Omura, János Lichtenberger and *Reinhard H. Friedel*
Eötvös Loránd University, Hungary

Neutron transport simulations in lunar surface regolith
Szabolcs Nagy and *Dávid Lucsányi*
Puli Space Technologies Ltd., Hungary

Popularizing space-related activities in the Z-generation
Ákos Gyenge and *Donát Takács*
BME Cosmos Society, Budapest University of Technology and Economics, Hungary

Simulated Mars Rover Model Competition – 2018 and 2019 back to the MARS
Attila Sipos and *Pál Gábor Vizi*
magyarokamarson.hu, Hungary

Simulating the effects of solar particle radiation on serum immu noglobulin N-GLYCANS by capillary electrophoresis analysis
András Guttman, Máté Szarka, Szabolcs Szilasi, Dániel Sárközy, Boglárka Dönczö and István Rajta,
Horváth Csaba Laboratory of Bioseparation Sciences, University of Debrecen, Hungary

Small steps towards strengthening the competitiveness in space research and technology - Space-related Education Initiative for Hungary
Andrea Strádi, László Bacsárdi, András Ordasi, András Illyés, Zsófia Bodó and *Dániel Szendrei*
Hungarian Astronautical Society, Hungary

Stereo-vision based navigation of mobile robots in pathless environments
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Sharif University of Technology Iran

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Pál Gábor Vizi
MTA Wigner Research Centre for Physics, Hungary

Thermal simulations and analysis of a lunar surface payload
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Puli Space Technologies Ltd., Hungary

UltimaSpace Experiments on the ISS
Flórián Vámosi and *Péter Pósa*
Mihály Táncsics Grammar School of Kaposvár Hungary

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Hungarian Astrophotographers' Association, Hungary

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On the hydrologic Impacts of Climate Change

Dr. János Józsa
rector
Budapest University of Technology and Economics, Hungary

Several aspects (causes and impacts, threats and disasters) of climate change have been investigated in the last few decades. In the paper the focus is put on some global and local hydrologic phenomena in that respect. Hydro-science and engineering related research activities at the Faculty of Civil Engineering of the Budapest University of Technology and Economics apply numerous airborne and space technologies in the investigation of e.g. the data of satellite measurements in high atmosphere and images of remote sensing based on drones as well as on satellites. The paper gives a number of examples of such relevant hydrologic phenomena including the ones with features seriously affected by climate change.

Keywords:
hydrology, climate change, aerial/space/satellite technology

Recent dosimeter developments for human spaceflight at the Centre for Energy Research, Hungarian Academy of Sciences

Attila Hirn
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Centre for Energy Research, Hungarian Academy of Sciences, Hungary

The dosimeter system Pille was developed in the predecessor of the Centre for Energy Research, Hungarian Academy of Sciences (MTA EK). The latest version, Pille-ISS, has been regularly used on board the International Space Station (ISS) for dose monitoring at different locations of the Russian Segment and for personal dosimetry during Extravehicular Activities (EVA) since 2003. The system is based on thermoluminescent (TL) technique and consists of a set of dosimeters and a reader. The dosimeters contain CaSO4:Dy as TL material integrated with their individual heater and a memory chip. After exposure, the dosimeters are read out automatically by inserting them into the reader and turning them [1, 2].

The Pille-ISS dosimetry system is easy to use and has proved its stability and reliability during the last one and a half decade. The measurement results processed by MTA EK and the Institute of Biomedical Problems, Russian Academy of Sciences (IBMP RAS) showed that due to the shielding of the case and the holder part of the dosimeter the dose values might be underestimated. This can be the case for dose measurements during EVAs at higher geomagnetic latitudes.

The Russian space radiation safety standards define dose limits for critical organs. During EVA, eye lens and skin are the most vulnerable because of their relatively thin (self)shielding. As the current dosimeter construction does not allow the measurement of eye lens and skin doses during EVA, at the moment experts of the radiation safety service of IBMP RAS use only estimations.

The modernized Pille-ISS dosimeters significantly reduce the shielding of the TL material. This modernization allows to measure skin and eye lens doses during EVA. The shielding reduction will allow to take into account dose increases from electron flu-

xes of the Van Allen radiation belts. The modernized Pille-ISS dosimeters are planned to be used also for measurements inside an anthropomorphic phantom (Matroshka-III) on board the ISS. In another phantom experiment, the MATROSHKA AstroRad Radiation Experiment (MARE) on NASA's first exploration mission (ORION Exploration Mission 1, ORION EM-1), our research group will provide passive dosimeter package comprising TL and nuclear track etch detectors to be used inside a phantom during the flight to estimate the dose to female astronauts to future trips to the Moon. Some preliminary information on this project will be also given in the lecture.

Keywords:
space dosimetry, human spaceflight, Pille, ISS, Orion EM-1

References:
[1] Fehér, I., Deme, S., Szabó, B., Vágvölgyi, J., Szabó, P.P., Csőke, A., Ránky, M., Akatov, Yu.A. A new thermoluminescent dosimeter system for space research. Adv. Space Res 1:61-66, 1981
[2] Apáthy, I., Akatov, Yu.A., Arkhangelsky, V.V., Bodnár, L., Deme, S., Fehér, I., Kaleri, A., Padalka, I., Pázmándi, T., Reitz, G., Sharipov, S. TL dose measurements on board the Russian segment of the ISS by the "Pille" system during Expedition-8, -9 and -10. Acta Astronaut 60:322-328, 2007

ABSTRACTS

A wide swath of Sentinel-based deformation monitoring applications in Hungary

Péter Farkas*, Gyula Grenerczy, Sándor Frey
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Geo-Sentinel Ltd, Hungary

Sentinel-1 satellites of EU's Copernicus Programme provide C-band synthetic aperture radar (SAR) data for both orbits, every 6 days, as a service. This can be used for many applications, including deformation monitoring of natural hazards and infrastructure. Permanent Scatterer Interferometry (PSI, PSInSAR) is one of the most advanced methods for long-term deformation monitoring using satellite radar data. It provides motion history time series for millions of points with mm/yr or better accuracy, that is a unique ability, incomparable to any other geodetic methods. On the other hand, surface deformation and motion or stability of various buildings and infrastructure elements could be important for many fields, including oil and gas, mining industry, civil engineering, disaster management, etc. These satellite radar-based deformation measurements give decision makers valuable information for investments, maintenance and safety aspects.

We present examples from our studies in Hungary, particularly two ongoing research projects. One focuses on improving lowland hydrological hazard assessments using Sentinel data, investigating the effects of subsidence on floods and inland excess water. The other is a feasibility study for health assessment and maintenance support of large-scale linear infrastructure systems, e.g. roads, railways and power lines. Their common feature is that they both exploit the large spatial and temporal coverage of Sentinel-1 satellites as well as the high accuracy and reliability of the PSI method. Beside these couple of examples of useful applications for the industry and the society, based on the unprecedented data flow of Sentinel-1, many new possibilities are waiting for exploration and continuous monitoring will also be inevitable where it matters most

Keywords: Sentinel-1; PSInSAR; deformation monitoring

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Building the First Hungarian Free-space Quantum Communication Device

Máté Galambos*[1], László Bacsárdi[1], Zoltán Belső[1], Eszter Gerhátné Udvary[1], Győző Gódor[1], Sándor Imre[1], Zsolt Kis[2], István Koller[1], János Kornis[1], Zsolt Papp[1], Viktor Zsolczai[1]

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In 2017, Hungary has started a quantum technology flagship project. The project is 4-year-long with a budget of roughly 10 million euros. One of the goals of this flagship project is to realize secure quantum communications. The national consortium working on the project has several members from various institutes including Ericsson Hungary, Nokia Bell Labs, BHE Bonn Hungary Ltd (a Hungarian aerospace company) as well as from academia and research institutes.

In the past years, we built the first Hungarian fiber-based Continuous Variable Quantum Key Distribution (CV QKD) device. Building on this experience, one of the current tasks is to achieve entanglement-based free-space quantum key distribution with a potential application in the satellite domain.

In preparations for these experiments, we analyzed the optical properties of atmospheric free-space channels. We have developed a mathematical model of loss for quantum-based satellite communication. Our model is quasi-classical and it is based on Gaussian beam propagation in the atmosphere. It takes into account several factors: the atmospheric losses due to molecular and aerosol extinction, technological limitations such as detector efficiency and photon production efficiency and it analyzes the effect of pointing error and beam spreading given a certain detector mirror size. We compared predictions of the model with experimental results, and a computer program based on the model is now available.

* corresponding author

On the experimental side, we have created and tested an entangled photon pair source at 850 nm wavelength based on a thin β-Barium borate (BBO) crystal pl te, using Type I phase matching condition. We tested this photon source in free space over short distances and successfully detected coincidences between the photon pairs.

The research is connected to COST Action CA15220 Quantum Technologies in Space. The research was supported by the National Research Development and Innovation Office of Hungary (Project No. 2017-1.2.1-NKP-2017-00001).

Keywords:
free-space, quantum key distribution

References:
[1] J. Yin, et al., “Satellite-based entanglement distribution over 1200 kilometers”, Science, Issue 6343, Volume 356, pp.: 1140–1144. (2017)
[2] A. K. Majumdar, J. C. Ricklin, “Free-Space Laser Communications Principles and Advances”, Springer, 2008, ISBN 9780387286525

CoderDojo and the emergence of informal space tech education ecosystems

Radu Ticiu*[1], Andrea Magyar[2], Virgiliu Pop[3]
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The present and future of education is one of the most discussed and disputed topics nowadays, in both developed and developing countries on both officials' and laymen's levels. Various educational system models successfully instaured in places from Northern Europe to South-Eastern Asia are analysed and evaluated as potential panacea for old and currently persisting societal problems. An emphasis on a higher weight for the STEM component of the new education approaches looks like a constant in countries focusing on gaining/retaining a better position in economic competitiveness or innovation nations' ranking.

Offering a more prominent role to STEM in K12 educational landscapes is done more and more often by including programming in the K12 compulsory curricula, but from political decision to the full implementation of the newly defined concepts in the formal educational systems, there are long and perilous roads.

In the context of the inertial character of the formal educational system, confronted with lack of vision, financial resources, infrastructure and needed staff, eroding the enthusiasm and interest of both students and parents, there are notable evolutions resulting in setting up and functioning of informal, free-to-attend, non-profit education initiatives.

The paper will expose how the local clubs in Timisoara Metropolitan Area network of CoderDojo (a global initiative of free programming education clubs for kids aged 7-18, started in Ireland, 2011), centers the creation and evolution of an ecosystem of space science and technology education, by bringing space-themed activities within dojos' current activities, by enrolling and supporting teams in or locally organizing space robotics

* corresponding author

competitions, by attracting mentors and corporate sponsors, high-schools, university-based research teams, by encouraging kids' active participation to hackathons, summer camps, meetups, etc.

The paper will analyse this informal space science and technology education ecosystem's topology and relationships, evolution and potential for further growth and will offer a set of recommendations for model replication in various environments.

Keywords:
informal education, space education, education ecosystem, CoderDojo

References:
[1] Computing our future - Computer programming and coding. Priorities, school curricula and initiatives across Europe; Publisher: European Schoolnet (EUN Partnership AIBSL); Contributors: Anja Balanskat, Katja Engelhardt; Brussels 2015 http://www.eun.org/documents/411753/817341/Computing+our+future_final_2015.pdf/
[2] Cansat National Competition Winners 2018 https://www.edu.ro/premian%C8%9Bii-competi%C8%9Biei-na%C8%9Bionale-cansat-2018

Detection of Tsunamis based on Ionospheric Satellite Signals

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We detect tsunamis based on ionospheric satellite signals. The measurement of changes in the ionosphere are based on total electron content (TEC) values. The TEC values are calculated from the GPS satellites' L1 and L2, P1 and P2 signals. The TEC values are smoothed with a Kalman filter.

According to historical data, the curves of the TEC values show a characteristic change when a tsunami occurs. In the current phase, we present a novel method of calculating TEC curves based on data from early 2000s.

Keywords:
total electron content, TEC, ionosphere, satellite, tsunami

References:
[1] Komjathy, A. (1997), Global Ionospheric Total Electron Content Mapping Using The Global Positioning System, PhD Thesis, University of New Brunswick
[2] Komjathy, A., Y.-M. Yang, X. Meng, O. Verkhoglyadova, A. J. Mannucci, and R. B. Langley (2016), Review and perspectives: Understanding natural-hazards-generated ionospheric perturbations using GPS measurements and coupled modeling, Radio Sci., 51, 951–961

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Determination of 3D surface deformation for the 2018 Oaxaca earthquake using InSAR

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SAR images acquired along descending and ascending orbits maps a surface deformation from different angles. Accordingly, the surface deformation they show are affected by foreshortening and related projection errors. However, by combination of two deformation models, they can efficiently be used for 3D deformation modelling [László-Földváry, 2018]. In this study, reconstruction of the surface motions due to the 2018 Oaxaca earthquake is attempted, with the joint use of a Sentinel-1A [Berger et al, 2012] deformation model taken along a descending orbit and a Sentinel-1B deformation model taken along an ascending orbit. The Line-Of-Sight deformations from different views, similarly to the concept of stereophotogrammetry, could have efficiently been used for determining the 3D deformation vector [Hu et al, 2010].

The observation equation lead to an ill-conditioned, irregular, inhomogeneous systems of linear equations, which could have efficiently been solved by minimizing the least squares of the corrections and inverting the normal matrix by Singular Value Decomposition. As for the results, from geophysical considerations, realistic deformation vectors have been obtained.

Keywords:
InSAR, Sentinel-1, ascending/descending orbit, deformation analysis, 3D modelling

* corresponding author

References:
[1] Berger, M. Moreno, J., Johannessen, J. A., Levelt, P. F., Hanssen, R. F.: ESA's sentinel missions in support of Earth system science, Remote Sensing of Environment, 120, 84-90, 2012
[2] Hu, J., Li, Z. W., Zhu, J. J., Ren, X. C:, Ding, X. L.: Inferring three-dimensional surface displacement field by combining SAR interferometric phase and amplitude information of ascending and descending orbits, Science China Earth Sciences, 53:4, 550–560, 2010
[3] László, G., Földváry, L.: Application of Sentinel-1 data for determination of surface deformation due to volcanic and seismic events, 17th edition International Technical-Scientific Conference Modern Technologies for the 3rd Millennium, 55-60, ISBN 978-88-87729-49-8, 2018

Developing Balloon-Borne Payload for Remote Sensing Applications

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For remote sensing and earth observation purposes the usage of satellite technology means a common solution. It is a widely used technique to obtain useful data in several fields of interest for research, environmental and industrial key players. With these methods it is possible to gather data about landmarks, patterns, crops, forests, minerals, water and various other resources Besides the usage of satellite technology there are other ways for gathering remote sensing data.
One of them is remote sensing from stratospheric balloons. Although there have already been proof- of-concept launches, which show significant research and industrial opportunities in this area, this method is still not widely researched. The technology is relatively cheap, easily accessible and can be developed, integrated and launched quickly if needed.

This paper focuses on the development of a low cost, small size, balloon-borne remote sensing payload using COTS (Commercial off-the-shelf) components and how stratospheric balloons could be used to perform localized, small scale remote sensing missions. The UPRA Project (Universal Platform for Robotics and Aerospace) is a student project with an aim to develop a reliable, widely configurable, low maintenance, high altitude balloon platform for university research groups. The development team consists of the members of the Simonyi Károly College for Advanced Studies at the Budapest University of Technology and Economics.

The aim of the project is to build a proof-of-concept multispectral remote sensing hardware and using open source and self-developed software to analyze data provided by the payload to demonstrate that high quality and relevant remote sensing can be achieved for a comparably low price.

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The remote sensing payload is planned to have two identical images sensors with a pixel resolution of 1600x1200px. The selected sensor has a wide spectral sensitivity in visible and near-infrared range (420nm – 980nm). Applying different optical filters on the sensors would lead to near identical images in different spectral range. Using infrared-pass filters, the payload will be able to collect data on vegetation and urbanized thermal footprints.

With a stratospheric balloon large areas could be covered during a flight and balloons could be launched in a frequent manner. The collected data could help authorities to organize protection or salvage during floods, after hails or storms. Also valuable information could be provided to the agriculture on vegetation covered areas and inland waters from sowing to harvest, with the help of regular scientific remote sensing balloon missions in Hungary.

Keywords:
high altitude balloon, remote sensing, earth observation, agriculture

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Educational Aspects of Developing a High Altitude Balloon Platform

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Space industry struggles to find qualified engineers with hands-on experience in space-related technologies. Even though the higher education in Hungary has a broad spectrum for engineering students, it lacks aerospace or space engineering courses available in the country. This educational gap means a shortage of experienced employee and thus a high amount of personnel costs for the space companies.

This paper focuses on the possibilities of enhancing and combining the higher educational studies with student-led projects aiming to teach skills and competencies that are necessary in the space and aerospace domain. The UPRA Project (Universal Platform for Robotics and Aerospace) is a student project with an aim to develop a reliable, widely configurable, low maintenance, high altitude balloon platform for university research groups. The development team consists of computer science and electrical engineering students, who are members of the Simonyi Károly College for Advanced Studies at the Budapest University of Technology and Economics.

Besides the scientific goals of the project- such as providing a frequent flying opportunity for university experiments to the stratosphere - the educational aim is to provide an easily accessible hands-on experience for university students with a high variety of tasks in a space related project's lifecycle. With the mentorship of the Hungarian space industry, the team develops most of its workproducts internally, from the project management processes, the electronics schematics, the launch and recovery procedure.

During the development phase, the students have the opportunity to learn system engineering skills, quality management in the space domain, embedded software engineering for flying mo-

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dules and ground station development and management. Also, since the project is delivering flight opportunities to experiences from other universities and organizations, it provides system integration knowledge for the participants.

Another important aspect of the space industry is the difficulty of testing. We can make several simulation, unit and hardware-in-the-loop testing but the field testing can only be done during the launch.

One of the strengths of the project is a thorough retrospective section. After each launch and recovery sessions the team holds a series of meetings to collect the lessons they learned during the development, validation and launch. During these events it is important that the team members learn important aspects about system engineering and effective project management.

There are many possibilities for the project for further growing. A closer cooperation with the key industry players and the universities can hold several aspects for further enhancing the educational value.

Keywords:
high altitude balloon, higher education, system engineering, STEM education

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ESA perspective on lunar surface exploration

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The first lunar robots landed more than fifty years ago on the surface of the Moon. Humans followed shortly, but the interest faded away after the Apollo missions. Today, space agencies and private companies are aiming for the Moon again and this time the goal is to establish a more sustainable way of exploring it, and even possibly a permanent human presence on the surface.

The new missions to come will be robotic surface explorers, as shown by the recent Chinese mission Chang'E 4 . The European Space Agency ESA is working in cooperation with Roscosmos, the Russian Space Agency Roscosmos to develop new capabilities in the area of landing, in-situ resource utilization and communications.

In particular, ESA is developing two packages for the Russian Luna-27 mission: one as a platform system called PILOT (Precise and Intelligent Landing using On-board Technologies), the other one as a payload called PROSPECT (Package for Resource Observation and in-Situ Prospecting for Exploration, Commercial exploitation and Transportation).

PILOT will enable precise and safe landing by providing absolute/relative navigation and hazard detection and avoidance functionalities [1].

PROSPECT will take samples from the lunar regolith and its onboard miniaturized laboratory will analyze the presence of volatiles, such as water. This will be a first characterization step towards potential ISRU (In-Situ Resource Utilization) [2].

ESA is also studying the international Heracles mission concept, [3] that will rely on the Deep Space Gateway to establish an access to and return from the lunar surface. The Heracles mission would deliver a rover on the surface and bring back samples.

Although the Google Lunar X-Prize ended in March 2018, a number of European groups are still active in developing such lunar landing missions, accessible at a lower cost by providing commercial services. ESA is investigating under which conditions a partnership with them might be established.

To conclude, ESA is pursuing complementary avenues to foster lunar surface exploration in Europe, with a first flight opportunity on the Roscosmos Luna-27 mission.

Keywords:
Moon, ISRU, robotic exploration

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Landing_on_the_Moon_and_returning_home_Heracles (Nov. 26, 2018)

Estimating 3D Rain Fields with Satellite Beacon Measurements

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In the Department of Broadband Infocommunications and Electromagnetic Theory (HVT) at Budapest University of Technology and Economics, we participate in the Alphasat scientific experimentation program, where propagation and communication measurement activities are carried out. The propagation measurements in Ka/Q frequency bands are serving to determine the atmospheric impact on radio wave propagation and the estimation of different statistical distributions, while the communication experiment in the Q/V band is used for diversity and Adaptive Coding and Modulation (ACM) studies. The wave propagation from the Alphasat were measured and discussed from a practical point of view, taking advantage of the availability of measurements from various instruments. The results showed that predictions can be calculated with reasonable accuracy, provided that some practical considerations are taken into account.

In view of this, we are proposing a novel idea to be used in satellite propagation measurement to estimate rain field dimensions and the shape of a cloudy area. Alphasat and also other communication satellites are equipped with beacon transmitters using unmodulated signals for technological measurements. By receiving these signals from the satellite at three or more different geographical locations we can use the attenuation measurements to calculate rain intensity along the radio path, and from this, we can estimate the shape of the clouds in three dimensional state.

The EXCELL model would be the applied to model the rain cells. This model will be used to describe the variation of rainfall rate within a cell as an exponential or elliptical profile.

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This work is part of an ongoing activity, to calculate the shape of the clouds using satellite beacon signal measurements and construct 3D models of the rain fields. In this paper it will be demonstrated how to calculate the rain intensity from the attenuation data, use the EXCELL model to determine the side view of the rain fields at different locations. The calculation is done by simulating the interaction of geomertical links of the represntations in the rain field in 3D model.

Keywords:
rain cell, rain, millimeter wave, radiowave, propagation

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Evaluation of plasma properties from ground measurements for radiation belts modeling

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Radiation belts models have developed significantly recently due to important missions, like Cluster, THEMIS, Van Allen Probes, MMS. These missions provided valuable data sets: useful for model validation, also essential for setting boundary and other key parameter inputs. Unfortunately, such missions are barely capable for long-term, real-time and global monitoring. Here we present a new tool to produce some of these parameters applying recordings from the Automatic Whistler Detector and Analyzer Network (AWDANet), which is a global VLF receiver network consisting of 28 stations.

To reach our goal, an inversion method was designed to provide thermal plasma population parameters from characteristics of chorus emissions only. The nonlinear wave growth theory of Omura (Omura et al. [2008, 2011]) served as the basis, assuming that the triggering wave is originated by the linear cyclotron instability Firstly, we tested the chorus-inversion method on in-situ data of Van Allen Probes (EMFISIS, HOPE) in the generation region of chorus emissions. We found that the theoretical amplitudes are consistent with the measured ones. The relation between linear and nonlinear wave growth agrees with our basic assumption, namely, linear growth is a preceding process of nonlinear wave growth. As a second step, we completed the chorus inversion method with the model of chorus propagation along the Earth's magnetic field to the ground assuming collisionless, cold plasma and dipole magnetic field. To validate this model, simultaneous recordings of AWDANet and VAP were processed. These different recordings gave back the same results, therefore the use of this simple propagation model is satisfactory.

As a next step we will apply this inversion method on more chorus emissions which are detected in various magnetic local times and various geomagnetic conditions.

Keywords:
wave-particle interaction, chorus inversion, Van Allen Probes

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Exploitation of Sentinel-1 SAR data for studying geodynamic, tropospheric and ionospheric processes

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Radar images acquired by spaceborne SAR (Synthetic Aperture Radar) instruments have been used extensively by the scientific community for biomass estimation, surface deformation mapping and monitoring, land cover classification, flood mapping in the last twenty years. The availability of SAR scenes, however, was limited until the launch of the Sentinel-1 A and B satellites in 2014 and 2016, that ushered in a new age of SAR remote sensing, thanks to the open access data policy of the Copernicus Earth Observation Program of the EU. Sentinel-1 IWS (Interferometric Wide Swath) SAR acquisitions provide wide area coverage and ensure short revisit times (6 days in Europe, 12+ days outside of Europe).
One of the main usages of SAR images is the interferometric processing, that yields so-called interferograms that contain the phase differences between two SAR scenes. The interferometric phase is the combination of different phase terms including surface deformation (if present), atmospheric, ionospheric, topographic, noise. The accurate estimation and separation of these terms allow the analysis of the (geo)physical and geodynamic processes related to the origin of the phase components.
We wish to demonstrate that it is possible to separate the aforementioned phase components and use the resulting phase to study geodynamic and atmospheric phenomena such as landslide evolution (with the help of corner reflectors), large scale surface deformation trends in the Transylvanian Basin, change of water vapour content in the atmosphere and ionospheric electron content variations.

Keywords:
InSAR; remote sensing; earth observation; geodynamics; atmosphere monitoring

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Inspiring the Next Generation in the Hungarian Space Camp

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In 1994, the Hungarian Astronautical Society (MANT) started the series of the Hungarian Space Camps, with the intent of introducing the space research and astronautics to the youth during a one-week- long summer camp. The organizer of the program is the oldest Hungarian non-profit space association, founded in 1956. This society gathers Hungarian space researchers, users of space technology and everyone who is interested in the interdisciplinary and state-of-the-art uses and research of outer space. The aim of MANT is to raise public awareness about space exploration and uses. It also provides opportunity for space enthusiasts to meet, exchange ideas and work together.

In 2018, 25 Hungarian students arrived from Hungary and Hungarian regions of Ukraine and Romania in the Hungarian Space Camp. From the campers, 8 students were already participated at previous space camps. Based on the traditions of the previous years, where the programs were built on a selected topic, like asteroid mining (2016) or game and sport in the space (2017), in 2018 the key topic of the camp was the Moon Village concept. The participants were divided into 5 membered groups and they had to work on a week-long project which was related the weekly topic. The 13 talks given by Hungarian experts also helped the students by providing useful information about the given topic.

The program also included trips, technology presentations, and different activities like the space quiz, sport and other team building games, movie night and observation of the night sky and the Sun with telescopes. Additional highlights of the program were different technical visits including a field trip to a self-driving car test race road or a technical visit at a nearby university.

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The authors of the paper were the camp leaders in 2018. In our work, we focus on lessons learned from the experiences gained in the Space Camp. We shortly introduce the organization structure, the schedule of the camp with its main activities, and the different selection process of the participant students and lecturers. We highlight some challenges we met during organization and lessons learned in different fields.

Keywords:
space camp, space education, outreach

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Investigation of stochastic disturbances in satellite connected terrestrial millimetre wave wireless mesh network

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The radio spectrum below 6 GHz is almost fully occupied and will be further saturated by increasing number of IoT devices of 5G systems. Cognitive radio (CR), whose first concept was proposed in [1], is one of the most important emerging technologies to solve these problems. The primary users or incumbents in a CR system are the main owners of the spectrum. To avoid interference with the primary system secondary or opportunistic users are utilizing the free or unused resources in the CR environment, taking into consideration that the quality of service of the incumbents cannot be degraded [2]. However, if there are one or more non cooperating interference sources as secondary users of the same radio spectrum the quality of service (QoS) of the primary system cannot be guaranteed without applying appropriate techniques to reduce and/or avoid these disturbances. Such techniques includes interference elimination methods like serial or parallel interference cancellation (SIC or PIC) or other methods keeping the required signal to interference and noise ratio (SINR) for example by power adaptation of the transmitters of the primary system.

This contribution deals with a moving interference source as secondary user disturbing a primary system of dense millimetre wave terrestrial mesh network where all or some of the nodes have also satellite connection. This incumbent configuration has high potential in 5G, because the densely deployed nodes are access points (base stations) for broadband services. Satellite links to the nodes can be used for providing broadband content of global interest cashed by the nodes whereas the terrestrial millimetre wave links distribute instantaneous information of local interest, therefore guarantying low latency for end users.

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Beside backhauling the 5G millimetre wave wireless mesh network can also be obtained as a sensor network. Any kind of stochastic disturbance for example a randomly moving interference source like a non-cooperating secondary user of the same spectrum in the area of the mesh cause SINR degradations at the nodes that are correlated in space and time, therefore theoretically allowing the detection and prediction of the disturbing effect. Using the gathered data (for example SINR values at the mesh receivers) an appropriate method (e.g. AI) for prediction of the influence of the disturbing effect could be applied. With proper prediction of the power of interfering signal it is also possible to decrease energy consumption of the mesh network through transmit power adaptation fulfilling the goal of green communication.

Keywords:
Satellite links, millimetre wave terrestrial mesh, green communication

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Neutron transport simulations in lunar surface regolith

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The high energy protons and heavy ions of the cosmic rays are continuously bombarding the surface of the Moon causing different nuclear reactions and creating secondary neutrons in the lunar surface regolith. The analysis of the lunar surface neutron radiation is essential for prospecting and in-situ utilizing the lunar water ice inside permanently shadowed regions [1], or performing astronaut dosimetry calculations for future manned missions or lunar habitat designs [2].

At Puli Space Technologies, we have performed Monte Carlo neutron transport simulations using Geant4 [3] and Fluka [4] open -source particle transport codes developed at CERN. The elastic and inelastic scattering of neutrons have been studied in different mixtures of regolith and water ice, as well as in biological shielding which could be constructed in-situ from lunar regolith. The results are various lunar surface neutron spectra, especially in the thermal and epithermal neutron energies, depending on the ice/regolith ratio, regolith type and thickness. Our results will be used as input for the design and optimization of a Total Non-Ionizing Dose (TNID) measurement on the lunar surface.

This is a publication of Puli Space Technologies Ltd.

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Keywords:
Lunar, Neutron, Regolith, Water ice, Simulation, Spectroscopy, Dosimetry

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Popularizing space-related activities in the Z-generation

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The potential of space activities today is beyond question. However, it is a common experience of people working in this field that the public opinion does not reflect these possibilities, which are often seen far-fetched. In this paper, by applying the Overton window [1] and other models in public relations to the common image of space today, we present possible ways of broadening the public understanding on this topic. We support these claims with our experience as the founders of the first space-related student organization (Cosmos Society) at Budapest University of Technology and Economics (BME).

While trying to popularize our society at our university, we gained valuable insights on the specifics of communicating space activities to the members of the Z-generation. First, we discuss the reasons for making such topics common talk, by several examples, such as the public communication of anthropogenic climate change [2], the Instagram-effect [3] and the recent activities of Elon Musk.

Then, we present our experiences on communicating space-related topics to university students, based on our personal understanding and the interaction data of different post genres from our Facebook page.

We conclude that there are three important factors to keep in mind when wanting to raise public awareness of space activities. Firstly, one should keep the topics as broad as possible. Secondly, one should focus on showing the various faces of space activities in our everyday life with simpler communication, instead of longform discussions with a narrow scope and technical jargon. Thirdly, occasional sensational and seemingly unnecessary actions often have a greater effect on public understanding than continuous, gradual change.

Keywords:
space activities, public outreach, Overton-window, Z-generation, student society

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Quantum Tracking a Dataset – a New Application of Quantum Cryptography

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There are situations when we judge the trustworthiness of our communication partners based on their physical location (like the Pentagon versus the capital of a rogue state).

Therefore it would be useful to have a cryptographically secure system for authenticating the location of our communication partners. Using this system a cooperating communication partner (called the prover) could prove to secure stations (called verifiers) that he is where he says he is–in the honest case. Attackers who lie about their location would fail this test with high probability–in the dishonest case.

Unfortunately, we have mathematical proof that location authentication is impossible using classical communication [1]. However–according to our current understanding–location authentication is possible using quantum channels (ideally satellite quantum channels) if the attacker has limited resources [2] [3] [4]. This is because resources required for the best known universal attack scale exponentially as function of the resources required in the honest case.

However, location authentication proves only that someone responds from the authenticated location. The verifiers know nothing about who their communication partner is or if it is the same person during repeated attempts of communication. This makes it impossible to use location authentication to track the location of something.

We present a new method based on location authentication that can be used to track the location of a dataset. First valuable data is encrypted and stored in quantum bits. Then other random data (called the tracker) is concatenated to these quantum bits.

* corresponding author

Finally, some secret unitary operation ensures that potential attackers do not know how to separate the valuable data from the tracker. (Such a unitary operation could be a random shuffle of qubits or a series of randomly chosen controlled negations. These would sufficiently scramble the dataset "mixing" the valuable data and the tracker.)

The verifiers at any point can require the carrier of this prepared data to perform another unitary operation that produces two separable quantum states: the first is a large sequence of tracker bits and the other is a mixture of the remaining tracker bits and the valuable data. If the tracker bit sequence is long enough then it is protected against a general attack and its location can be authenticated. This process can be repeated–verifying the location of the dataset over and over again–until all the tracker bits are used up.

Keywords:
location authentication, quantum cryptography, tracking

Radio interferometry for the study of Jupiter's icy moons

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The JUpiter ICy moons Explorer (JUICE) is a large-class interplanetary mission of the European Space Agency, to be launched with an Ariane 5 rocket in 2022. The spacecraft will arrive at the largest planet of our Solar System after a long journey of more than 7 years. During its anticipated 3-year lifetime around Jupiter, JUICE will study the gas giant and three of its large Galilean moons (Ganymede, Callisto, and Europa) that are believed to have oceans of liquid waterunder their icy crust.

One of the eleven science experiments of JUICE is PRIDE (Planetary Radio Interferometer and Doppler Experiment). This is unique in the sense that it does not require any specific onboard instruments beyond those available on the spacecraft anyway. PRIDE will employ the technique of very long baseline interferometry (VLBI) involving an extended network of ground-based radio telescopes to observe the carrier signal of JUICE transmitter together with celestial radio sources. This way, the spacecraft position can be accurately determined in the celestial reference frame.

In this presentation, I will briefly introduce JUICE and speak about the PRIDE principles and science applications. Finally I will outline the preparatory works to be performed with VLBI to make sure the most science is squeezed out of JUICE.

Keywords:
Jovian moons, JUICE, VLBI, ephemerides, reference frame

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Satellite Fading Classification with Artificial Intelligence for 5G

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In this phase of the constantly changing and developing mobile telecommunication networks, the fifth generation (5G) networks are the future. There are many developments in 5G, such as increased throughput capacity, efficient energy saving and low latency. In the components of the network, which are using satellite communication, it is a great issue to handle low latency because of the great distances and some weather-related disturbances in the channel. In the Department of Broadband Infocommunications and Electromagnetic Theory (HVT), we participate in the Alphasat scientific experimentation program, which allows us to gather lots of measurement data and therefore information on the atmospheric impact on radio wave propagation in the Ka/Q frequency band.

Measurements are showing that a different type of precipitation in the air has a significant impact on increasing the atmospheric attenuation. When it is raining, we can see a well recognizable pattern in the fading of the channel. In the ongoing work, we are trying to use artificial intelligence to recognize and classify the pattern caused by rainfall events. The Alphasat satellite transmits unmodulated beacon signals that we receive and measure every second. This way we get long time series of data, that we then divide into smaller segments according to whether there was a rainfall event or not.

We are using MatLab, and its neural network toolbox to train networks to learn to distinguish between the rainfall event showing and the normal segments of the measured time series of data.

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Keywords:
rain, millimeter wave, radiowave, propagation, neural networks

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Simulated Mars Rover Model Competition – 2018 and 2019 back to the MARS

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Introduction: This is an annual report of the Magyarok a Marson (Hungarians on Mars) about 2018 and 2019. We reported the Competition in the previous years (Sipos, Vizi 2009-2018) for example at H-SPACE 2017, [1].

We put back the environment to a near Mars surface plotting board in the year 2018 with slopes, valleys, hills and canyons The task: The task was to go to the targets on path which were eight bouquet of balloons (red, green, blue and purple) and it was necessary for the competitors to burst out balloons with matching color of the team using a needle on a robotic arm during passing the full path. Two bouquet of balloons were put in harder places and they could only be reached through slopes and/or with robot arm with 3 or 6 degrees of freedom. The plotting board: Plotting board was built from some squares of extruded polystyrene (XPS) foam which could be easily formed to construct highland, slopes, rocks and cliffs. The trailer video of the Competition: Usually we show the frame story of the Competition in the videos. [2]

Solutions: We gave same wheels and motors to the teams of the competitors, as free of charge support to give equal conditions. Teams used Arduinos, PLCs, Wi-Fi, Bluetooth and mixed versions of solutions. The result, publications and several videos can be found on the net. In the picture You can see all of the robots. [3] The videos of robots in working state at the link. [3]

2019: The Plan and The frame story: The idea in 2019 is to save astronaut Mark Watney (from novel and movie “The Martian”). The task of 2019 is to carry there or to build a rescue robot in situ at the target place on the ‘Mars’. We want to keep and to open our contest to wide range of young people. Cheap parts

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(electrical, mechanical) are enough for the goal to build a competitive robot-rover. Those cheap parts can be reached on the Internet with wide range of possibilities.

The task: To build a rover with manipulator(s). We re-commend to use the cheapest steppers and servo motors and electrical components. Furthermore, it is possible to need a 3D printer (less than $ 400) to use it to construct, print and build a rover.

Keywords:
magyarok marson rover model competition

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Simulating the effects of Solar particle radiation on serum immunoglobulin N-glycans by Capillary Electrophoresis analysis

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On a roundtrip to Mars (~360 days), astronauts would be exposed to approximately 0.66 Sv (1) radiation dose, mainly due to Galactic Cosmic Rays (GCR) and Solar Energetic Particles (SEP).

This amount of exposure exceeds the lifetime limits here on Earth according to RAD measurements (1). Previous studies have shown that after extensive radiation exposure, inflammatory proteins such as citokines are induced in the human body. In general, radiation modulates the hematopoietic system (2). Under exposure to strongly ionizing radiation, serum immunoglobulin (IgG and IgM) levels in the blood initially drastically decrease even to hypogammaglobulinemic levels. However, in a long term, a regenerative hypercompensation is observed (3). Specific glycosylation patterns of these immunoglobulins, especially IgGs have already been associated with various ailments such as chronic inflammation, autoimmune diseases and malignant transformation just to mention a few.

The focus of our work was to profile the IgG glycans after medium-energy proton irradiation to reveal the resulting possible glycosylation profile changes. Structural elucidation will be accomplished by our small and lightweight image analysis based LED induced capillary electrophoresis system to decipher the effects and threats of SEP on possible physiological changes of future astronauts during long duration missions beyond the shielding environment of Low Earth Orbit (LEO).

Keywords:
CE; Immunoglobulins; N-glycans; Space travel;

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Small steps towards strengthening the competitiveness in space research and technology – Space-related Education Initiative for Hungary

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In contrast with several European countries, the Hungarian tertiary education palette lacks specialized (aero)space-related degree programs (e.g., aerospace engineering), however, the market clearly needs those. There are active science and engineering teams at different Hungarian universities and research institutes, in close cooperation with the intensively growing Hungarian space industry, yet the supply of young, committed specialists is scarce. The solution is not evident, as the current education system cannot properly comply with the expectations of the rapidly developing space activities, which are becoming more and more diverse.

Just recently, young space enthusiasts at the Hungarian Astronautical Society (MANT) a working group was formed on this topic, in the aftermath of the space education themed 'MANT Space Academy 2018' summer school. The MANT Space Education Working Group aims to provide a platform for the different stakeholders interested in starting the aerospace engineering curriculum in Hungary. These stakeholders include motivated university students, university professors working in the field of space science and engineering, space industry and government.

During the summer school a preliminary recommendation was prepared by the participants (aged between 18 - 35 years) based on roundtable discussions with professionals from universities, research institutes and the Hungarian space industry. This document summarizes the basic needs in competence revealed

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by the invited experts, together with the overview of the potential accredited – BSc, MSc, PhD – and other forms of education which could help meet these needs effectively. It is important to note, that prior to the summer school there were public discussions organized, and a questionnaire survey conducted in this field by the founders of the Working Group. [1], [2] The details of the recommendation and the general lessons learned will be presented as well.

In addition, our group aims to collect bright ideas from young people and raise the "space awareness", therefore organizing social events, which are perfect occasions to attract people towards to it. Besides fun, these gatherings provide spots for informal meetings or networking; and occasions to create collaborations and even find scholarship or job opportunities.

Keywords:
education, aerospace engineering, space awareness

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Space weather and Arduino meteo station

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Learning about the atmosphere, weather, climate change or space weather effect are important elements of environmental education in schools. The Romanian school curriculum is incomplete in terms of meteorology or climate issues; however, the students are curious about the causes of weather changes. For this topic, the school could offer many interesting learning opportunities and new ways of teaching.

This paper is based on two school meteo-projects that were used during the practical outdoor activities with the Science Club students. Students built various Arduino-controlled weather- stations to measure continuously the changes of atmospherically parameters (relative humidity, pressure, temperature, pollution, light intensity, etc.). During the other project, the movement of the NOAA meteorological satellites (NOAA 15, 18 and 19) is monitored by the students and the sent images are recorded. In both cases, the recorded, collected data is analysed, processed and interpreted. These projects and learning modules are designed to help students use real data to explore the atmosphere characteristics and enhance their understanding related the weather topics.

This novel and creative STEM process performed with Science Club students helps them to deepen their understanding of the internal connection between the theory taught in physics, geography, biology, chemistry and IT classes and those practical applications.

Keywords:
Arduino, mini weather station, education

Stereo-vision based navigation of mobile robots in pathless environments

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In this research a stereo vision-based algorithm for mobile robots navigation and exploration in pathless and unfamiliar outdoor environments (as space) is proposed. The algorithm is solely based on stereo images and implemented on a nonholonomic mobile robot.

The first step for exploration in pathless and unfamiliar environments is construction of the map of circumference in real-time. By getting disparity image from rectified stereo images and translating its data to 3D-space, point cloud model of environments is constructed. Then by projecting points to XZ plane and put local maps together based on visual odometry, global map of environment is constructed in real-time. An algorithm is used for investigating optimal path and nonlinear back-stepping controller guides the robot to follow the identified path.

Finally, the mobile robot explores for a desired object in a pathless and unfamiliar environment through these steps. Experimental results verify the effectiveness of the proposed algorithm in real-time implementations.

Keywords:
stereo vision, navigation, Mobile robot, exploration, pathless environments

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Streaming Swarms as Inter-Station and Interplanetary Transfer Pipes

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Introduction: The idea introduced here is a mission concept which describe a sketch of the Inter- Station and Interplanetary Transfer Pipes conception. Author's earlier work drawn up Streaming Swarm of Nano Space Probes as Mission and Instruments Concept [1].

The idea of Transfer Pipes is based on possibilities of nowadays technology. Let we presume that a streaming swarm can be controlled safely when significant elements of the stream can hold under rigorous control and it will not pose a greater threat than the use of other technologies or natural effects in space, e.g. micro meteorites.

To achieve a bigger and quicker matter transportation between space ships and planets it is necessary to have a transportation similar to pipe transport in Earth. Based on the descriptions of the previous articles higher speed (and quicker transportation) can be realized when we speeding up smaller spaceships, e.g. nano and pico ships. The importance of reaching a distant place in time is higher than we can reject the idea. For example, maybe we can transfer medicine drops, food, water, oxygen or defense parts, etc.

In case of a simple Streaming Swarm the deceleration is not necessary. In case of Transfer Pipes it is mandatory and the idea of Composite Sheaf Beam Lasers [1] technology maybe can realize both of acceleration and deceleration. In case of a planetary system the Hohmann transfer orbit can accomplish an elliptic free fall dropping transportation, but it is very time consuming. If we try to use the Transfer Pipe idea with Composite Sheaf Beam Lasers then orbits remain elliptic inside of the Solar System, but according to the high accelerating and decelerating at the target the high eccentricity orbit will asymptotically approach a straight line.

Safety: The shield against micrometeorites is necessary and space probes and satellites can usually bear this tribulation. The nature of Transfer Pipe must be remaining inside those kinetic and dynamic effects.

Conclusion: The Transfer Pipes technology idea gives us a possibility to transfer similar, small pockets of elements e.g. medicine drops or piles, food, water, oxygen or defense parts, etc. in a high speed transportation based on Streaming Swarms as shipping space crafts.

Keywords:
Streaming Swarm Interplanetary Transfer Pipes

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Studying the MART tomography approach under severe weather conditions

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Since the observed satellite-receiver distance of GNSS is affected by the water vapor, its amount can be estimated by the inversion of the positioning procedure. One can uses the zenith wet delay (ZWD) estimated during the processing of the GNSS observations.[1] The ZWD correlates well with the integrated water vapor, that is basically the total amount of water vapor in the atmospheric column above the GNSS receiver. Nowadays more and more national meteorological agencies utilize this information by assimilating the zenith total delays of GNSS observations in numerical weather prediction models. The limitation of this approach is that it is unable to provide information on the vertical distribution of water vapor. To overcome this problem, tomographic reconstruction techniques can be used for modelling the 3D spatial distribution of atmospheric water vapor causing the delays of GNSS signals in the slant, satellite-receiver directions. [2,3]

This paper introduces a tomographic approach using the multiplicative algebraic reconstruction technique (MART) [3] to estimate the three-dimensional distribution of water vapor over Hungary using simulated data under severe weather conditions. Slant wet delays are simulated using a ray-tracing technique at the stations of the Hungarian Active GNSS Network based on high-resolution numerical weather models with the resolution of 0.1°. The spatial distribution of the water vapor is reconstructed using the introduced tomographic technique. The results showed that the estimated model fitted to the simulated slant wet delays with the mean accuracy of 3%.

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The retrieved vertical water vapor profiles fitted well to the results of in-situ radiosonde observations, too. The results confirmed that the developed tomographic technique is suitable for estimating 3D atmospheric water vapour models, providing more detailed information for weather prediction, especially for the prediction of intense rainfall.

Keywords:
tomography, MART, water vapor

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The MarsQuake Program for Hungarian High School Students

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The MarsQuake project is intended to provide a set of teaching resources and classroom activities that will use the latest data and images sent back from the NASA InSight mission to Mars. The British Geological Survey, the National Space Academy and the Durham University together published a background science booklet aimed at 11–18 year-olds students. The publications contained different activities include modeling and locating meteorite impacts known as 'marsquakes'. A translation of this book for Hungarian students has been prepared in 2018.

The „MarsQuakes" program is available in the following areas in Hungarian:
Two websites:

MTA CSFK GGI: http://marskutatas.suliszeizmo.hu
Terkán Lajos Public Observatory: http://telapo.datatrans.hu/mars

These websites contain details from the MarsQuakes book, the history of Mars research, interesting facts about Mars, and seismological knowledge.

– Background science booklet in pdf format: "MARSRENGÉSEK – Szeizmológia más bolygókon" is downloadable from the websites above. In this booklet it is shown to the students how to look at seismic data using simple spreadsheets, semi-professional analysis software and simple computer programs, which they could write themselves.

– Open Facebook group, which is updated daily with news about InSight: – „ Marsrengések – kiből lesz marskutató?" (Marsquakes - who will be a Mars discoverer?)

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Scientific lectures and presentations:

Galileo Webcast – live broadcast: György Hudoba: Mars targeted!

Skeptics XXIV. National Conference (2018): Márta Kiszely: Marsquakes - who will be Mars discoverer?

Participations in popular scientific events (Earth Science "Whirlabout" in the Hungarian Natural History Museum, and in Budapest the Capital of Sciences 2018)

So far, there are about 25 candidates to MarsQuakes program, including one astronomical circle.

Anyone can join to this program, regardless of where they live. Currently there are applicants from Balatonfüred, Budapest, Dombóvár, Érsekújvár (Sovakia), Gödöllő, Gyál, Kerepes, Mátészalka, Sásd, Sopron, Szeged, Székesfehérvár and Szigetszentmiklós.

Keywords:
marsquakes earthquakes seismology

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The popularization of space exploration amongst high school students

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Space industry made possible for us to explore our universe by leaving the atmosphere of the Earth. It gives us great opportunities and challenges.

Recruitment and motivation of the students can not be started too early, and of course we also need some appropriate methods to keep up their interest. Many people believe, that the best time to pass through the most knowledge to the students could be the secondary school age. At this age, students already have the basic knowledge in physics and mathematics that makes them able to understand more complex problems.

In space research there are many areas, topics (e.g. astronomical facts, space exploration history, the ongoing projects in space research, future research plans and challenges) that are of great interest, and which are excellent for raising the interest and motivation of high school students for science courses.

After a short overview of the topics and some existing programs, I will present a self-made program for secondary school students that promotes the space research for them. The tasks also fit the subject of physics, mathematics and geography. This unconventional class is interactive by involving and activating students. I have already presented the program in three different classes in a secondary school in Budapest with great success. I share my experiences and analysis about the results with the audience.

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Keywords:
Education, Space research, Storyline method

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The RADCUBE project and beyond - Cosmic Radiation Monitoring CubeSat mission

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The RADCUBE project is a 3-unit CubeSat mission led by C3S LLC with Hungarian Academy of Sciences in Hungary and supported by the European Space Agency to demonstrate miniaturized instrument technologies. The primary objective of the satellite is the in-situ measurement of space radiation and magnetic field environment in Low Earth Orbit for real-time space weather monitoring purposes. The long-term vision of the project is the development of CROSS (Cosmic Radiation mOnitoring Satellite System), a constellation of similar instrumented satellites around the Earth with the aim of providing accurate measurement data for tracking the radiation received by spacecrafts, spacecraft components and astronauts.

In our work, we focus on the multidisciplinarity and the peculiarities of the complex small satellite project. The presentation will detail the development process, which requires unique engineering methods and solutions. The preparations for fleet-level reproducibility of the satellite platform will be described. From management side, the opportunities and challenges of the academic and industrial cooperation on international level will be highlighted. The future goals will be presented for both platform and payload site.

Keywords:
CubeSat, space weather, cosmic radiation

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The technology of CanSats, which can involve secondary school students in space

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A CanSat is a can-sized minisatellite used to teach space technology & science. It features very similar technologies like real minisatellites, which leave the atmosphere and orbit the Earth. They also have to perform atmospherical experiments. CanSats are often serve as a payload for sounding rockets/research rockets. Building a CanSat is a great opportunity for every student to begin with when they are interested in space, especially in space technology.

Various space organizations, agencies organize CanSat competitions with slightly different educational purposes. The CanSat Competition of the European Space Agency (ESA) 1 aims to give secondary school students and teachers a space-experience. The Hungarian Astronautical Society (MANT) is willing to organize the next year's Hungarian CanSat Competition with the same goal and also in order to select the Hungarian teams for the European CanSat Competition.

The official Hungarian CanSat team in the 2018 ESA CanSat Competition was Team HunSat 2 (András Illyés, Benedek Tomka, Domonkos Cseh, Domonkos Dessewffy and their teacher, Levente Dudás). We won a special prize with our technical achievements. We performed the following measurements as a Primary Mission (obligatory in the competition): temperature measurement, atmospheric pressure measurement. A so-called Secondary Mission (different scientific and/or technological missions chosen by the teams) is also obligatory. We chose the following topics: First of all, we did advanced telemetry (3-axis gyroscope; 3-axis accelerometer; humidity measurement; optical dust concentration measurement).

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Another mission of ours was the RF spectrum analyzation: measurement of the unnecessary RF emission in the GSM band, which means wasting money and which is harmful to the environment. We implemented a telecommand function, a two-way encrypted communication in the ISM band with a forward error correction algorithm. We built a targeted landing system: design and construction of a parachute which is almost a spherical cap, but it can be controled via control lines (cords) and a servo. The controling was done by a finite-state machine with a sense of intelligence: although it did not have data about the wind, it calculated the wind conditions from GPS data and past behaviour. To be able to do these, we designed our own PCB, we built a well impedance-matched radio, we made a spectrum analyzer and we designed a durable chassis and SLS-printed it.

The communication link, the telecommanding, and the advanced telemetry succeeded perfectly during the competition. We had some difficulties with the targeted landing system because of the big wind. Our main measurement, the spectrum analyzing was also successful.

Keywords:
minisatellite technology, education, spectrum analyzation,
satellite landing mechanism

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The Watermill-Project for Secondary Schools

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The flowing water has been exploited since ancient times to produce mechanical energy that was used for the most diverse purposes to move water mills to irrigation systems. Energy is not only the biological condition of man, but also one of the fundamental elements of any act of social production. It is applied to man's creative work in order to produce the essential goods of existence. Energy gives economic activity to its development, being one of the prerequisites and conditions of development and progress.

Renewable energy is an alternative source of energy that is increasingly used. Solar energy, hydroelectricity and wind energy are the main alternative energy sources implemented in more and more new housing projects. Nowadays, more and more emphasis is being placed on the search for and use of alternative sources of energy that do not affect the environment in which we live and, implicitly, the quality of people's lives. If renewable energy sources are used, the demand for fossil fuels is decreasing.

The objectives of the project have emerged from the need to create a transdisciplinary vision of the world in which we live, in order to achieve an overall picture of life. In order to adapt to a changing world, students need the widest knowledge of all areas of knowledge, but at the same time it is necessary for them to know how to connect them

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The project aims to develop different values and attitudes of students as:

1. developing the interest in information and scientific documentation;
2. developing curiosity about the environment;
3. developing the tolerance for others' opinions;
4. raising awareness and involvement in interdisciplinary issues;
5. raising confidence in scientific truths and critical appreciation of their limits.

Keywords:
watermill, school project, renewable energy

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Thermal simulations and analysis of a lunar surface payload

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The renewed interest to send spacecrafts to the lunar surface opens new challenges in thermal modelling. Puli Space Technologies Ltd. is preparing to send a static payload to the Moon onboard the Peregrine lunar lander [1] of Astrobotics Technology Inc., based on the former Google Lunar XPRIZE experience of the two companies [2].

The 1 kg active static payload will host scientific experiments, technology demonstrators and cameras, designed to operate on the surface for half a lunar day onboard the lander. A key enabler for the mission is the use of Commercial off-the-shelf components to significantly lower the costs of the mission. These components have narrower operating temperature ranges than traditional hardware used in space, which results smaller design margins and requiring more accurate thermal models both for the lunar lander, static payload and lunar thermal environment.

We have constructed a detailed 3d thermal model of the static payload and a simplified thermal model of the Peregrine lunar lander. Using Finite Element Analysis software, the external fluxes (direct solar, lunar albedo, lander albedo) have been calculated for the proposed landing site and time, as well as the internal heat dissipation of the electronics have been estimated. Worst cold and hot cases have been identified considering the lander orientation and the local surface topology near the lander (rocks, craters). Simulation results for the full mission duration were analyzed as the solar zenith angle changes. Based on our results, optimization of the payload structure and lander- payload thermal interface is ongoing.

This is a publication of Puli Space Technologies Ltd.

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* corresponding author

Keywords:
Thermal simulation, Thermal design, Lunar payload,
Lunar lander, COTS, Moon

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Transmission rates of lightning discharges into whistlers

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Whistlers are very low frequency (VLF) electromagnetic waves originating as lightning discharges on the opposite hemisphere and traveling through the inner magnetosphere along geomagnetic field lines[1]. We present a method to determine the geographic distribution of source lightning corresponding to whistler detector ground stations. Our method also determines the transmission rates of lightning into whistler as a function of geographic location.

We apply this method to ~70 million whistlers from fifteen ground stations in the AWDANet global whistler detector network and ~2 billion lightning discharges from the WWLLN global lightning detector network, from the period of 2007 to 2018. We present the obtained source lightning and transmission rate maps and discuss the results. Our results conform to the accepted theory of ducted whistler propagation[1], and resolve some controversies of earlier attempts to determine whistler source regions [2,3].

Keywords:
VLF, whistler, lightning, ducts, plasmasphere

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UltimaSpace Experiments on the ISS

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The UltimaSpace Experiments started in 2016, when the First European Astro Pi mission was launched by ESA and The Raspberry Pi Foundation [1]. Teams of students from all ESA member states could join the competition to design and code their space experiments that could be selected to run on the ISS. The codes had to be written in python and had to match the mission rules, so they could be executed on the Astro Pi computers already placed on the station.

In 2017 our code was selected as the only Hungarian entry to run aboard the station. Our experiment's main goal was to find the weakest points of the Earth's magnetic field. This was a very successful experiment, though it should be noted, that in compliance with the mission rules we only had 3 hours to collect the data. This means, that our data covers only two orbits, which is a very narrow path. Our results can be seen on our website [2].

In the fall of 2017 the second Astro Pi Mission was announced, we have been selected for phase 2 of the competition but didn't make it to the final or the station. Last year we were planning on measuring the light pollution over Europe with the Astro Pi's Infrared camera, the use of which was prohibited in 2016-17. Our main objective was to see whether we can distinguish dark sky protection areas [3] from cities at night, in addition to following up on the magnetic field experiment from the preceding year.

In 2018 when the now yearly Astro Pi mission was announced, we have entered again, learning from the previous year's mistakes. We are now in phase 2 and writing our code for the experiment. This year we are also measuring light pollution levels, but instead of ground-analysis, we are planning on utilizing some onboard processing to make our code more advanced. In addition to the main experiment we are still planning on following up on our 2017 Magnetic-Field Experiment. The software will also

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collect useful sensor information as metadata, what we can us for example to calculate the average density of the Earth.
The Astro Pi Mission gives a great opportunity for students to learn about space and the importance of coding and logic at the same time. Over the years the mission helped us improve our problem-solving skills and reach our goals.

Keywords: education, Astro Pi, space experiments, research-based teaching, space generation

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UV Spectrophotometric Time Series Analysis of the Herbig Ae Star HD 163296

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The benchmark Herbig Ae protoplanetary disk HD 163296 has revealed substantial and often unexpected variability in its accretion (transport of material from disk to star), inner disk structure, outer disk appearance, intermittent "dipper" extinction (blocked light) events, a bipolar jet, periodic Herbig-Haro (HH) knot ejections (jets hitting and heating gas blobs in the interstellar medium or ISM), and a disk wind. We suspect that inner disk variability or material ejected from the star, driven by either an instability or by one or more forming giant planets, is responsible for the variable appearance of the outer disk as traced by scattered light imagery. However, because the scope of the system's variability has only recently been appreciated, the different flavors of variability and the impact that they have on one another have not been analyzed in a unified, self-consistent manner. Variability in young stellar objects is a common trait across many wavelengths. Flux changes in some UV studies (e.g. Pérez+ 1993) are thought to be at least partially related to changes in the stellar accretion rate.

HD 163296 is surrounded by a large disk (450 AU, Grady+ 2000), a bipolar jet (Devine+ 2000), and chain of HH knots. HD 163296 has is one of the key objects which has accumulated a big "data-pile" over the past 40 years, and is an undeciphered Rosetta stone for relating its variability at different wavelengths and thus from different parts of its disk+jet system. We rectify this shortcoming for HD 163296 by coherently analyzing UV spectra over 1978-2017 in flux and time.

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HD 163296 UV data include > 150 observations with the International Ultraviolet Explorer satellite (1978-1995), 3 Far Ultraviolet Spectroscopic Explorer satellite observations (2001-04) and 7 Hubble Space Telescope spectra (1998-2017). All are open-access. We present an analysis of the (a) time-scale, (b) amplitude, and (c) wavelength-dependence of variations in the archival data for HD 163296, using standard astronomical software (IDL/IRAF/Python) from the HST and FUSE teams.

Keywords:
Herbig Ae/Be stars, young stars, proto-planetary disks

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Why Astrophotography is the Best Promotion for Space Exploration and Astronomy?

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Astrophotography is the use of photography to depict astronomical phenomena. Up until the beginning of the 21 st century, photographing the night sky, effectively was the privilege of professional astronomers, due to the lack of inexpensive digital cameras. In the early '00s when inexpensive digital cameras came to the market, astrophotography was reborn and became available for the general public [1].

The interest in astrophotography started growing exponentially in the last couple of years. This is thanks to the further advancement in camera sensor technology and the overall steeply decreased cost of beginner equipment.

Hungarian astrophotographers are among the most successful in the world. Since 2012 a year hasn't passed without a Hungarian astrophotographer winning an international award. The growth is unstoppable, and the underlying community made a decision to form the Hungarian

Astrophotographers' Association as the first country-wide astrophotography organization in the world. The association's main duties include building and maintaining the community, promote space-exploration and astronomy by presenting the work of Hungarian astrophotographers to the public, to provide international relations for Hungarian astrophotography and to determine the ethical limits for astrophotography as a style as well as provide guidelines and an accessible knowledgebase to keep them [2]. Astrophotography by professional astronomers was always considered solely a scientific activity. This means that when imaging an object, esthetics generally weren't taken into consideration.

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This changed at the end of the ‘90s when NASA hired a group of artists to process the images of the Hubble Space Telescope [3]. Since then astrophotography has been used to raise interest in Space Exploration and Astronomy. This is relevant because astrophotos are the way to show the public what they can’t see with their own eyes, but indeed is out there. The public is not impressed by a dataset or a graph, but astrophotos can catch people’s eyes and they might become interested in science afterwards. This is great promotion to raise interest and get funding for science. It can also be used to raise public awareness of scientific culture, especially among young people. This helps to fight challenges of the future, which can only be solved by a scientifically and critically thinking society. In addition, the data that is collected by astrophotographers has scientific value for scientists. This shows, that while astrophotography is mainly about the esthetics of the images it can help the advancement of science both fundamentally and culturally.

Keywords:
astrophotography, outreach, science popularization, scientific culture

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H-SPACE 2019

The 1st International Conference on Research, Technology and Education of Space was the opening event of the conference series. It was held on February 13, 2015.

The 2nd International Conference on Research, Technology and Education of Space was held on February 25-26, 2016.

The 3rd International Conference on Research, Technology and Education of Space' was held on February 9-10, 2017.

The 4th International Conference on Research, Technology and Education of Space' was held on February 15-16, 2018.

The 5th International Conference on Research, Technology and Education of Space' was held on February 27-28, 2019.

H-SPACE 2020, the 6th International Conference on Research, Technology and Education of Space' is planned to be organized in February, 2020 in Budapest, Hungary
The Call for Papers will be available from September 1 on the http://space.bme.hu website.