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PROCEEDINGS OF THE 6th INTERNATIONAL CONFERENCE ON RESEARCH, TECHNOLOGY AND EDUCATION OF SPACE

H-SPACE 2020

Edited by László Bacsárdi and Kálmán Kovács

MANT
Magyar Asztronautikai Társaság

EIT
EGYESÜLT INNOVÁCIÓS ÉS TUDÁSKÖZPONT

BME VILLAMOSMÉRNÖKI ÉS INFORMATIKAI KAR

Proceedings of the 6th International Conference on Research, Technology and Education of Space

February 26-27, 2020, Budapest, Hungary
at Budapest University of Technology and Economics

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

Editors
László Bacsárdi and Kálmán Kovács

MANT 2020

Conference proceedings

H-SPACE 2020
6th International Conference on Research, Technology and Education of Space
February 26-27, 2020, Budapest, Hungary
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WELCOME from the Organizing Committee

Welcome to the 6th edition of our H-SPACE conference series!

We are happy to welcome you at the 6th 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.

The topic of this year's conference is "Special focus on education of the next generation". In 2019, Budapest University of Technology and Economics – together with its partners – officially initialized the establishment of the space engineering MSc curriculum, this is why we decided to have our strong focus on the education at H-SPACE 2020. 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: a Plenary with a keynote presentation by ITU representative Ms. Mehtap Dufour and poster flash talks; Science and Technology I-III and Educa-

tion and Outreach I-III from which Science and Technology III and Education and Outreach III will be a poster session with 24 great presentation. The conference will have 3 side events: a Hungarian workshop organized by the Hungarian Astronautical Society Wednesday early afternoon, an AstroQuizNight Wednesday evening and a Telecommunications Club event Thursday evening organized by the Scientific Association for Infocommunications (HTE), an IEEE ComSoc sister society.

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. We hope to welcome you again at the next edition of H-SPACE, at the H-SPACE 2022, which will be organized in February 2022.

László Bacsárdi
co-chair
Vice President of MANT

Kálmán Kovács
co-chair
Director of BME EIT

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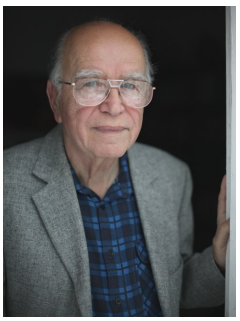
Welcome

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



The featured topic of this year's H-SPACE conference is „education of the next generation". In more specific drafting it is the education of space science, technology and applications in universities. It goes without saying that it is a very important task for the present generation of members of the space community. We need replacement in almost every aspect of space activity. The reason is that space industry is developing fast in almost every country, but higher education of future experts of this important field is usually not a high priority task of universities. Why is it so complicated to organize courses of space science and technology? The reason is the complexity of the subject: the students should learn rocketry, satellite technology (including many subdivisions, like communication, thermal energy etc.), celestial mechanics, navigation in outer space, construction of space-rated instruments and components as well as several aspects of application of satellites for solving urgent problems of mankind. Is such a programme for a course too difficult for a university? May be, but our important task is really to educate the next generation.

PROGRAM

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

February 26, Wednesday

Location: Building I, ground floor, I.B.027 (and I.B.019)
Magyar tudósok krt. 2., Budapest, H-1117

13:00 Greetings (in Hungarian)

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

13:05 Discussion (in Hungarian):

Paradigmaváltás az űrhajózásban: a magánűrhajók;
A kereskedelmi űrhajózás fejlődése *(Changing trends in space flights: development of the private sector)*
Participants:
András Ferenc Horváth, Honorary Member, MANT
Gábor Zsombor, Galileo Webcast
Moderator:
Előd Both, President, MANT

Session Chair: László Bacsárdi

14:00 Opening ceremony

Orsolya Ferencz, Ministerial Commissioner, Ministry of Foreign Affairs and Trade
Hassan Charaf, Dean, Faculty of Electrical Engineering and Informatics, BME
Előd Both, President, Hungarian Astronautical Society
Kálmán Kovács, President, BME Space Forum

14:15 Keynote presentation

Outcome of World Radiocommunication Conference 2019 (WRC-19) from space perspective
Mehtap Dufour, ITU Radiocommunication Bureau, Switzerland

14:50 Poster flash talks (Session Science and Technology III and Education and Outreach II)

Poster authors presents their work in 1 minute

15:10 Poster session with coffee break

Parallel sessions

Session Chair: Zsófia Bodó

15:40-18:00: Technical presentations – Session Science and Technology I

Invited presentation:

Hungarian perspectives in Earth Observation
Dániel Kristóf, Lechner Non-Profit Ltd.

Complete 3D Coseismic Deformation Field Reconstruction of 2019 Ridgecrest Earthquakes based on Sentinel-1 TOPS data
Bálint Magyar and Ambrus Kenyeres, Lechner Non-Profit Ltd., Hungary

The GNSS stream gauge
Ágnes Ács and Szabolcs Rózsa, BME Department of Geodesy and Surveying, Hungary

Shielding optimization for the RM-RAD-S Radiation Monitor
Boglárka Erdős, Attila Hirn and Balázs Zábori, Centre for Energy Research, Hungary

Visualization and simulation of ion thrusters possibly usable by small satellites
Árpád Makara, András Reichardt
and László Csurgai-Horváth,
BME Department of Broadband Infocommunications and EM Theory, Hungary

Pneumo planet Mars habitat and Moonbase
Thomas Herzig and Gábor Bihari, pneumocell, Austria

ESA perspective on lunar surface exploration and resource utilization
Mátyás Hazadi, European Space Agency, Netherlands

Antarctic Winterovering in Terrestrial Space Analogues: Cultural Differences in Emotional Expression
Bea Ehmann, Attila István Kiss, Eliza Kollerits, Barbara Matulai, Borbála Tölgyesi and László Balázs
Research Centre for Natural Sciences, Institute of Cognitive Neuroscience and Psychology, Hungary

Area classification and change detection from a time series of remote sensing images by using fusion Markov Random Field model
Tamás Szirányi, *SZTAKI, Hungary*

Session Chair: Dorottya Milánkovich

15:40-18:00: Technical presentations – Session Education and Outreach I

Invited presentation:

Space Academy: A Journey from Hospital to Mars
Rachael Dixon,
Edinburgh Children's Hospital Charity, United Kingdom

Education and outreach activities in Bükk Starry Sky Park
Richárd Novák, Anna Apró and István Gyarmathy,
Eszterházy Károly University, Hungary

Martian Climate Database – an online tool to model the Red Planet
Bernadett Pál,
Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Hungary

Astronomy Clubs for extracurricular Activities in Schools
Oancea Carmen-Adina and Ilesan Daniela Florentina,
Colegiul National Octavian Goga Sibiu, Romania

From the Torsion Balance to Space Gravimetry
Annamária Komáromi,
Balassi Bálint Secondary School, Budapest, Hungary

We Touched Space Twice in 2019
Flórián Vámosi and László Vámosi,
Mihály Táncsics Grammar School of Kaposvár, Hungary

Rocket technology for secondary school students
András Illyés,
Budapest University of Technology and Economics, Hungary

Mouse-on-the-Mars and other developments with secondary school students
Balázs Újvári,
University of Debrecen Hungary

Official H-SPACE 2020 event

20:00-22:00 AstroQuizNight (in English)
Organized by András Ordasi (MANT)
Location: KEG Sörművház, Orlay u. 1., 1114, Budapest

February 27, 2020, Thursday

9:00 Welcome coffee

Session Chair: Andrea Strádi

9:45-11:30: Technical presentations – Session Science and Technology II

Radio Frequency Interference Monitoring at locations in Nógrád County
L. Viktor Tóth, Krisztián Bodzsár, Orsolya Ferencz, András Jánosik and Péter Vári,
Eötvös Loránd University, Hungary

Deployment of the Hungarian E-GNSS Network and the results of its first year of operation
Bence Takács, Rita Markovits-Somogyi and Mercedes Reche
Hungarocontrol, Hungary

Pioneer chemical formulation experiments on ISS
Gergő Mezőhegyi, Ferenc Darvas, Ibolya Leveles and Beáta Vértessy,
InnoStudio Inc., Hungary

Evaluation of the space debris environment and active removal options based on drag-sails and electrodynamic tethers
Niklas Wendel, Louisa Gerhard and Tilman Hofbauer,
DEBRIS project group of German network of young scientists - juFORUM e.V., Germany

Invited presentation:

Developing European capabilities: the push for next generation optical telecommunication technologies
Christopher A. Vasko,
European Space Agency, Netherlands

Invited presentation (via web):

Future of cubesats
Chantal Cappelletti, University of Nottingham, United Kingdom

11:30-12:00 Poster session with coffee break

12:00-12:05: Opening of Session Education and Outreach II

János Józsa, Rector, Budapest University of Technology and Economics

Session Chair: Szabolcs Rózsa

12:05-13:20: Technical presentations – Session Education and Outreach II

Invited presentation

SMOG-P and ATL-1 PocketQube Class Satellites at BME
Levente Dudás and András Gschwindt, BME Department of Broadband Infocommunications and Electromagnetic Theory, Hungary

The importance of educating students about careers in the space sector: a student perspective
Jacob Smith, Sophia Lee Roberts and Laura Martin, UK Students for the Exploration and Development of Space, United Kingdom

Establishment of the Hungarian Space Engineering Curriculum
László Bacsárdi and László Csurgai-Horváth, BME Department of Networked Systems and Services, Hungary

Investigation of new methods in the education on the field of space communications and space research
Péter Vári and Elek Sántha
Széchenyi István University, Győr, Hungary

Doctoral School in Geospatial Science in Uzbekistan
Lóránt Földváry, Valéria Balázsik, Béla Márkus, Andrea Pődör, Malgorzata Verőné Wojtaszek, Ilhom Abdurahmanov and Mamanbek Reimov,
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Uzbekistan

13:20 Closing remarks. Best presentation award ceremony

Official H-SPACE 2020 event

18:00-20:00: HTE Telecommunications Club (in Hungarian) Outcome of the WRC-19 from Hungarian point of view
Organized by the Scientific Association for Infocommunications, Hungary (HTE)
Location: Building I, ground floor, I.B.019

Poster presentations (Session Science and Technology III; Session Education and Outreach II)

Adapting Telescopes for Optical Communication
Máté Galambos, Lili Létai, Zsolt Papp, Sándor Imre and László Bacsárdi
BME Department of Networked Systems and Services, Hungary

Affordable statistical testing for quantum random number generators in space applications
Balázs Solymos and László Bacsárdi
BME Department of Networked Systems and Services, Hungary

An overview of the usage of artificial intelligence-based algorithms in satellite operations
Barnabás Futó, Mátyás Papp, Bálint Petró, István Arnócz and Radim Basdi,
Space Apps Ltd., Hungary

Asteroid deflection with solar sail and laser-based techniques
Dávid Farkas and László Bacsárdi
BME Department of Networked Systems and Services, Hungary
Astrophotography in physics class
Maria Pető,
Székely Mikó Theoretical High School; ELTE-MTA Content Pedagogy Research Group, Romania

AstroQuizNight - An event where space doesn't part us but connects us
András Ordasi, Konkoly Observatory, Hungary

Automated and Remote Controlled Satellite tracking station
Elek Sántha and Péter Vári,
Széchenyi István University, Győr, Hungary

Current State of the Free-Space Quantum Key Distribution
Laith Al-Soub and László Bacsárdi
BME Department of Networked Systems and Services, Hungary

Deformation monitoring using persistent scatterer interferometry and open-source software
Bence Ambrus and Szabolcs Rózsa,
BME Department of Geodesy and Surveying, Hungary

Demonstrational Remote Sensing Payload Development for High Altitude Platforms
Zsófia Bodó and Bence Dávid Góczán, Budapest University of Technology and Economics, Hungary

IRSEL: Innovation on Remote Sensing Education and Learning
Malgorzata Verőné Wojtaszek, Valéria Balázsik,
Lóránt Földváry and Béla Márkus
Inst. of Geoinformatics, Óbuda University, Hungary

Local Ionosphere Modelling with GPS in Hungary
Balázs Lupsic and Bence Takács, BME Department of Geodesy and Surveying, Hungary

Planetology Aspects in University Education of Geography and Environment
Csaba Patkós, János Mika and Arnold Gucsik
Eszterházy Károly University, Eger, Hungary

Precise Orbit Determination and Prediction using GNSS and SLR observations
Szabolcs Rózsa and Bence Turák
BME Department of Geodesy and Surveying, Hungary

Radiation test facilities at Atomki and their space research applications
András Fenyvesi, József Molnár and István Rajta
Atomki, Hungary

Satellite Images to Support Contribution of Meteorology to the UN Sustainable Development Goals (2016-2030)
János Mika
Eszterházy Károly University, Eger, Hungary

Shoot an asteroid – linking laboratory based meteorite mineralogy to European space mission by university support
Ákos Kereszturi, Ildikó Gyollai, Sándor Józsa,
Ágnes Skultéti, Bernadett Pál, Dániel Rezes and
Máté Szabó, Research Centre for Astronomy and Earth Sciences, Hungary

SiPM based detection of cosmogenic production of radioisotopes in spacecraft substances
Bence Godó, Dávid Baranyai and András Fenyvesi,
University of Debrecen, Hungary

Space weathering-related evolution of fine-grained asteroidal and cometary materials: sample return planetary missions
Arnold Gucsik, Eszterházy Károly University, Eger, Hungary

Testing the visualization l of the Martian surface with GIS and SIMWE modelling tools
Vilmos Steinmann and Ákos Kereszturi,
Konkoly Thege Miklós Astronomical Institute, Research Centre for Astronomy and Earth Sciences, Hungary

The importance of self-education through the method of citizen science from the basic experiments to the serious emergencies
Péter Pusztai and Judit Turi,
Hungarian Astronautical Society, Hungary

The Technology Transfer Program of the European Space Agency from the Perspective of Budapest University of Technology
Bernard Adjei-Frimpong and László Csurgai-Horváth,
BME Department of Broadband Infocommunications and Electromagnetic Theory, Hungary

The work of Cosmos Society on introducing the importance of space to the general public
Ákos Gyenge,
BME Cosmos Society, Budapest University of Technology and Economics, Hungary

Thermal Thorium Rocket (THOR) – a new concept for a radio active decay heated thermal rocket engine
Gábor Bihari, University of Debrecen, Hungary

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KEYNOTE AND INVITED PRESENTATIONS

Outcome of the world radiocommunication conference 2019 from space perspective (WRC-19)

Mehtap Dufour
mehtap.dufour@itu.int
ITU (International Telecommunication Union),
Geneva, Switzerland

The World Radiocommunication Conference 2019 (WRC-19) has agreed on key parameters for future communication technologies. The importance of satellite communication has been affirmed firmly and a clear path ensured for the growth of the current and future technologies.

WRC-19 revised the Radio Regulations and agreements signed by 3400 delegates from around 165 Member States were enshrined in the Final Acts of Radio Regulations, the invaluable international treaty governing the global usage of radio-frequency spectrum and satellite orbit resources.

Protections were accorded to the Earth-exploration satellite service (EESS), meteorological and other passive services in adjacent bands, such as the space research service (SRS) to ensure that space-based monitoring of the earth and its atmosphere remain unhindered. Satellite services supporting meteorology and climatology that aim to safeguard human life and natural resources will be protected from harmful radio-frequency interference, as will systems used by radio astronomers for deep space exploration.

Necessary steps were also taken to ensure that radio astronomy stations would be protected from any harmful radio interference from other space stations or satellite systems in orbit. Regulatory procedures established for non-geostationary satellite constellations in the fixed-satellite service, opening the skies to next generation communication capabilities.

A new innovative milestone-based regulatory decision taken for the deployment of non-geostationary satellites in specific bands and services. In recent years, multiple satellite mega-constellations consisting of hundreds to thousands of spacecraft

in Low-Earth orbit (LEO) are evolving very fast toward global telecommunications, broadband internet access and also remote sensing, space and upper atmosphere research, meteorology, astronomy, technology demonstration and education. Regulatory changes made to facilitate rational, efficient, economical and interfrence free use of radio frequencies and associated orbits, including the geostationary-satellite orbit.

Additionally, protection of frequency assignments of broadcasting-satellite service (BSS) ensured to provide a priority mechanism for developing countries to regain access to spectrum orbit resources. Global maritime distress and safety (GMDSS) expanded coverage and enhanced capabilities.

The decision taken on Earth stations in motion (ESIM) will connect people while in planes, maritime vessels, and land vehicles to communication links with geostationary satellites in Ka bands. Conditions for communication of ESIMs with non-geostationary space stations in the fixed-satellite service will be further defined in WRC-23.

Keywords:
WRC-19, ITU, satellite, non-geostationary, WRC-23

References:
WRC-19 (https://www.itu.int/en/ITU-R/conferences/wrc/2019/Pages/default.aspx),
Provisional Final Act(https://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.13-2019-PDF-E.pdf)

Mehtap Dufour

Mehtap Dufour is one of the senior satellite communication engineer of Satellite Systems Coordination Division of Space Services Department. She is responsible from international coordination procedures for space systems and earth stations technical and regulatory examination of frequency assignment notices submitted by Administrations (Membership) for inc-

lusion in the Master International Frequency Register (MIFR). Mehtap has had more than 25 years' experience in all aspects of Satellite Communications Operations International regulations and also project management. Ms. Dufour has represented SSD at different Radiocommunication Conferences, assistance given to different member states for technical and regulatory examination procedures of satellite network notices.

Previously, she was part of the higher level management team of Satellite Communication Department of Turk Telecom, in Ankara. She put her signature to different satellite projects, one of them was like project manager of DMIP (Defense Mediterranean Improvement Project), which was assuring uninterrupted and secure satellite communication to different sites of the project.

Mehtap holds an electrical and electronics degree from Middle East Technical University, Turkey and also she also took satellite communication post-graduate courses from Surrey University, England.

She is married with one girl(17) and a boy(15) and lives in Geneva, where the Headquarter of ITU located.

The future of cubesats

Chantal Cappelletti
Chantal.Cappelletti@nottingham.ac.uk
University of Nottingham

Since early nineties CubeSat standard is revolutionising the idea of Space mission. From the first academic projects, where this small satellite was used to train university students, CubeSat applications increased so fast to be now used as reliable system for Mars and Moon missions. World-wide coverage at low costs is now the objectives of the so-called Mega-constellations designed by new private companies.
But what is a CubeSat and how it is changing the future of space missions?
This talk will give you an overview of the past, present and future CubeSat missions pointing the attention to the added values of this relatively new standard. An overview of the small satellite market and future applications will help to emphasize the concept of CubeSat as a standard to change our approach to space.

Chantal Cappelletti

Chantal Cappelletti is Member of International Academy of Astronautics, Assistant Professor at University of Nottingham, where is affiliated with Nottingham Geospatial Institute. Her activities are mainly concerning Microsatellite design, manufacturing and launching, with special attention to CubeSat platform. She has been leader of 6 satellite projects from Italy (UNISAT program and others) and from Brazil (SERPENS), PI of 2 missions concerning cancer cells behaviour on space and ASI delegate at IADC. She is the co-owner of the Italian company GAUSS Srl.

Developing European capabilities: the push for next generation optical telecommunication technologies

Harald Hauschildt, Josep Armengol, Eric Wille, Christopher A. Vasko*
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European Space Agency (ESA), Noordwijk, The Netherlands

The SatCom market is a global, multibillion EUR market that is one of the cornerstones of the traditional commercial space market. In the recent years, with the slow decline in customer demand for Satellite Television and the slow rise of broadband internet demand, the market for conventional Very High Throughput Satellite (VHTS) satellites has come under pressure to adapt for emerging future markets. While these might not yet present concrete business cases in the tangible near future, the data rates in the Tbps range projected from current market trends, as well those derived from studies on system architectures for 5G, new IoT concepts or manned lunar and deep space missions exceed current data capabilities by far.

The European Space Agency is engaged in stimulating the European space industry to address this matter by various initiatives to develop the next generation of optical telecommunication technologies (OTS). The European Data Relay System, for example, has already established the feasibility of OTS, and positioned European industry in a global leading role.

Amongst many ESA driven initiatives to foster European competitiveness, this paper aims to introduce the recently funded special programmatic line called Scylight. Amongst various aspects of ScyLight, the High thRoughput Optical Network (HydRON) vision will be discussed in detail.

* corresponding author

The ambition of HydRON is to seamlessly integrate a space optical transport network into existing terrestrial high capacity network infrastructure. Dubbed “Fibre in the Sky”, the vision entails interconnected all-optical payloads by means of optical inter-satellite links in the Tbps regime.

Keywords:
Optical Telecommunication Technologies, Hydron,
space technology

Christopher Vasko

Christopher Vasko has experience in engineering, academia and international organisations. He has obtained a PhD in applied physics from Eindhoven University, where he could bring his passion for space, science and engineering together working on cold plasmas for industrial applications. His interest in space ranges from strategy and policy to engineering, STEM education and outreach.

Currently he is working as Telecommunication Systems Engineer at the European Space Agency, mainly focussed on new optical telecommunication technologies. This is following a postdoctoral position as an Research Fellow at ESA's Headquarters in Paris, where he worked on various topics concerning national space strategies and innovation policies.

Hungarian perspectives in Earth Observation

Dániel Kristóf
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Earth Observation Unit, Lechner Knowledge Centre,
Budapest, Hungary
ESA Delegation, Department of Space Research,
Ministry of Foreign Affairs and Trade, Budapest, Hungary

Earth Observation (EO) has deep roots in Hungary. It was initiated already in the 1970's, with working groups created at several major universities and research institutes. Later on, Remote Sensing has become an independent discipline with dedicated organizations and resources. Agricultural and later environmental applications were put in focus, yielding operational projects since the 1980's.

International cooperation started and the Hungarian Space Office was founded in 1992. Hungary was the first Central European country to sign the Cooperation Agreement with the European Space Agency (ESA) in 1991, yielding several EO projects financed from ESA budget. Later, the country's contribution to the Plan for European Cooperating States also covered the field of Earth Observation. An EO ecosystem consisting of universities, research institutes, public institutions, private companies and NGOs was established and started to develop, covering both upstream (hardware) and downstream (analysis and applications) sectors.

Finally, Hungary became full member of ESA in 2015. With its accession, the country gained voting rights in ESA's governing bodies, and a number of financing mechanisms became available for Hungarian entities. In the meantime the European Earth Observation system, including Copernicus / Sentinel satellites and Earth Explorers, became world leader with the launch of a great number of satellites providing unparalleled scientific and operational services. Hungarian companies successfully contributed to this achievement as sub-contractors to international integrators. Hungary's contribution to the optional ESA Earth Observation programme was only decided in 2019, and the country has joined the Earth Observation Envelope Programme (EOEP-5) at its final stage, in May 2019.

At that time, ESA boards and experts were already working on an even more ambitious space programme, including the development of an enhanced Earth Observation system. Member states supported ESA in this effort by committing a record amount of nearly 12.5 billion Euros to the space programme, of which 2.5 billion Euros for Earth observation programmes over the next three years, including more than 1.8 billion euros for the Copernicus programme. Hungary has subscribed with an amount of 14 million Euros, of which 7 million to the Copernicus programme and 7 million to Future EO, the novel EO envelope programme with a lot of innovative elements.

With this important contribution, Hungary has become a significant player on the ESA EO ground. Lots of opportunities, both upstream and downstream, are now open and coming up to Hungarian entities. It is of crucial importance to get to know these possibilities and to maximize the return of country-level investments to domestic players. This requires dissemination, cooperation and further integration to the international ecosystem. The presentation gives an overview on ESA EO programmes and presents current and upcoming opportunities, focusing specifically on Hungarian entities.

Keywords:
Earth Observation, ESA, Copernicus, Future EO, Hungary

References:
ESA Science for Society – thematic webpage:
https://eo4society.esa.int/
ESA Copernicus thematic webpage: https://www.esa.int/
Applications/Observing_the_Earth/Copernicus
ESA EMITS tender information page: http://emits.sso.esa.int/
emits/owa/emits.main
ESASTAR registration page for external entities: https://esastar-emr.sso.esa.int/

Dániel Kristóf

Dániel Kristóf is the head of the Earth Observation Unit at Lechner Knowledge Centre. Graduated MSc in Environmental Management from Szent István University (Hungary) in 2000, he obtained a joint PhD degree in Environmental Science / Remote Sensing from Université Paul Sabatier/CESBIO (France) and Szent István University (Hungary) in 2005. He worked as Assistant professor at the Dept. of Geomatics of Szent Istvan University from 2004 to 2007. After joining FÖMI, the predecessor of Lechner Knowledge Centre in 2007, he has worked on several national and international projects in the field of big geospatial data processing. Since May 2019, he has been representing Hungary as a delegate in the Earth Observation Programme Board of European Space Agency (ESA) upon mandate from the Ministry of Foreign Affairs and Trade. His research topics include analysis of optical remote sensing data along with the integration and classification of heterogeneous geospatial data sets.

Space Academy:
A journey from hospital to Mars

Rachael Dixon
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Being in hospital can be a very frightening and lonely experience, especially as a child and especially when in an isolation unit. A patient may be in isolation either because they are infectious to other patients or because they are immunosuppressed, and it is dangerous for them to be around other patients and illnesses. Edinburgh Children's Hospital Charity (ECHC) is developing a Space Academy programme which aims to take the isolation experienced by these children and mirror it with the experience of an astronaut in space, thereby using the idea of space exploration to inspire children who are at their most vulnerable, and hopefully lessen the negative impact hospital experiences may have on a child. ECHC's Space Academy is a 3-week programme which sees each child through the stages of their mission to Mars, right through from pre-launch to debrief. A video-guided app is being developed to take them through their journey, with Tim Peake having agreed to record the introductory video. Each day offers different activities which follow this narrative, and which have been developed to abide by infection control restrictions within the hospital environment. Many of these activities are designed to parallel the work of scientists and astronauts, having used ESA resources aimed at school teachers as a guideline. The programme will therefore provide the children and young people with a way to engage with science whilst in hospital, at a time when they may be missing out on mainstream education. The programme is due to be trialled in the oncology ward of the Edinburgh Royal Hospital for Sick Children in 2020, since many cancer treatments result in a lowered immune system which requires the patients to be in isolation. This paper outlines the need for such a programme, the details of the planned pilot initiative and discusses the potential future development and reach of the project.

Keywords:
space, Mars, clinical isolation, hospital, STEAM

Rachael Dixon

Rachael is currently a fifth year Physics undergraduate at the University of Edinburgh. With ambitions of becoming a teacher, Rachael has been involved in various outreach projects during her time at university and is also the current Vice Chair of UK-SEDS. She is currently working with the local children's hospital to develop a 'Space Academy Programme' for children in the isolation wards, linking their isolation to the isolation that astronauts experience, whilst also working as a part-time project worker at the hospital - leading a coding club, 1-to-1 STEM sessions and youth group amongst other things.

SMOG-P and ATL-1 PocketQube class satellites at BME

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To follow the educational path in satellite development, during the lifetime of MASAT-1, in 2014 a new group of university students carried on with satellite development at Budapest University of Technology and Economics (BME). To reduce the costs and development time, the team had decided to work with the PocketQube standard. Thus the development of 1 PQ (5x5x5 cm) SMOG-1, SMOG- P and 2 PQ (5x5x10 cm) ATL-1 size satellites begun.

The primary payload of SMOG-1 and SMOG-P satellites is the spectrum monitoring system in the digital video broadcasting television (DVB-T) frequency band on the Low Earth Orbit (LEO). This man-made RF radiation, known as electromagnetic smog (hence the name) can cause interference in LEO satellite communication. The secondary mission of the SMOG satellites is the measurement of total ionizing dose with suitable field effect transistors (FETs) on-board. This makes it possible to estimate the operational lifetime of the satellites. As an additional payload, SMOG-1 features a special magnetic hysteresis material mounted on the side panels below the solar cells to decrease the life span of the orbit to minimize the time during which the satellite acts as space debris.

The primary mission of ATL-1 satellite is the on-board thermal isolation demonstration of three different and special thermal insulator materials in vacuum and micro-gravity to regulate the temperature of the batteries. ATL-1 also features the DVB-T based spectrum monitoring system as SMOG1 & SMOG-P.

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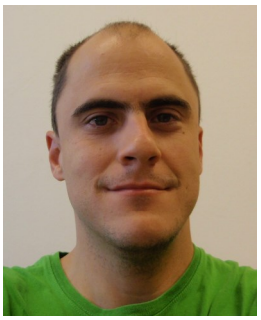
SMOG-P and ATL-1 had been successfully launched from New-Zealand with Electron rocket (RocketLab) in 06.12.2019 09:18 (MEZ): SMOG-P and ATL-1 are working, SMOG-P is the first operating 5x5x5cm satellite in the world.

On the top of building E at BME, the automated and remote controlled satellite tracking and control station called BME GND can be found. This control station has 4.5 m diameter parabolic type aperture antenna and a high precision azimuth-elevation antenna rotator. This enables us to track satellites with the main beam of the antenna with circular primary radiator (21 dBlin, 24dBcirc gain, 8 deg. main beam width).

The PocketQube class satellites are operating on the 70 cm radio amateur frequency band: SMOG-1 at 437.345 MHz, SMOG-P at 437.150 MHz and ATL1 at 437.175 MHz - coordinated by NMHH, IARU and ITU: http://gnd.bme.hu/.

Keywords:
PocketQube, RocketLab, spectrum monitoring, SMOG-P, ATL-1

Levente Dudás



Levente is currently a senior lecturer at BME Dept. of Broadband Infocommunications and Electromagnetic Theory, works as electrical engineer in Microwave Remote Sensing Laboratory. He is interested in radar & passive radar technology from the digital signal processing part via the analog intermediate and radio frequency units to the digital beamformer antenna systems and satellite-space technology: he was the communicational system engineer of the first Hungarian satellite called Masat-1, he is the com & system engineer of PocketQube class satellite projects at BME: SMOG-1/P (5x5x5cm) -the first smallest operational satellite in the world with scientific onboard payload- and ATL-1 (5x5x10cm).

ABSTRACTS

Adapting telescopes for optical communication

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Quantum communication uses extremely weak laser signals to transmit information. Free space quantum communication uses line-of-sight link via the atmosphere or the vacuum of space (e.g. between two satellites.) In this regard it is similar to laser communication except the beams are so weak, that they contain only a few photons and they are described by the probability density of one or more photons arriving to a specific point and the phase of the photons. The significance of free space quantum communication is that it can bridge much greater distances using satellites than optical fibers can.

However these weak probability beams must be aimed and focused with high precision. This can be achieved using telescopes. The method have been demonstrated in the literature between ground stations bridging more than 140 km distance [1] and between a satellite and a ground station bridging about 1700 km distance [2].

Our group has started adapting commercially available telescopes for this task. We examined the properties of two specific Maksutov–Cassegrain telescopes and tested methods for aiming and focusing laser beams. We performed these tests using classical laser sources, and these tests also served as a means to verify our mathematical models describing beam propagation through the atmosphere.

We tested the minimal diameter of the beam waist we can achieve under different circumstances and examined the link budget between a sender and receiver telescope. Experimental results are in the same order of magnitude as calculated results, there is no precise agreement between calculated and measured valu-

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es. We found that the link between the two telescopes operated around 45-50% efficiency at a couple of hundred meters distance under strong optical turbulences. However we believe that with the proper adjustments this efficiency can be increased.

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

Keywords:
Free space, Laser communication, Telescopes

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Affordable statistical testing for quantum random number generators in space applications

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Many cryptographic and communication use cases today rely on random numbers. Quality of these numbers is usually critical for security [1], thus requiring the use of quality true random number generators. QRNGs (Quantum Random Number Generators) [2] present a promising solution to satisfy this growing demand. They work according to the postulates of quantum computing [3] and offer random numbers based on physically proven unpredictable behavior.

Overseeing the operation of such devices can prove to be a challenge given the random nature of the output. This expected unpredictability makes detecting faulty operation states hard. Due to the probabilistic nature of the measured properties, statistical tests can be used to achieve this goal. These tests, however, are often computationally expensive and give feedback only on a single aspect of the data, requiring multiple different to be run for proper verification. In resource scarce situations, like on satellites, this can present a problem. Since we would like to use as few of our limited available resources as possible onboard a satellite to generate and verify randomness for cryptographic applications, we need to minimalize the resources needed for related calculations.

Using our previously developed flexible framework for statistically testing quantum number generators, we investigated the possibilities of making computationally more affordable statistical monitoring systems. The main idea behind the proposed optimized schemes is the following: with proper analysis of the built generator, a priori information can be collected regarding most possible future error states.

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This information can later be used to construct custom tests tailored to indicate the aforementioned states, reducing the need for other, more general tests. Creating a general model for some frequently used QRNG types and some of their associated operating error sources, we explored the feasibility of these reduced test systems. Investigating a general model presumes a simplified case compared to actual reality, however, even in this case, the viability of the mentioned practices can be shown.

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

Keywords:
random numbers; quantum computing; satellite communications

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An overview of the usage of artificial intelligence-based algorithms in satellite operations

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As humanity tries to reach further into deep space, the need for fast and efficient methods of diagnosing the faulty behavior of spacecrafts are increasing. But near-Earth missions too could benefit from efficient anomaly detection methods, as the monitoring burden placed on operation engineers is increasing with the spacecrafts becoming more complex and more data is generated. Autonomous behavior is becoming especially desired in situations where data transmission is too energy and time consuming.

In this paper, we try to evaluate the possibility of enhancing the diagnostic process of several spacecrafts by advanced anomaly detection methodologies. We will try to use telemetry data from the ESA Venus Express satellite, among other CubeSats from various near-Earth projects. We try to discover the possibilities of using artificial intelligence to efficiently classify faulty behavior, while also summarizing the opportunities for implementing traditional machine learning software and comparing the two approaches. Next to anomaly detection we also discuss AI-based image processing methods.

Keywords:
Artificial Intelligence, Machine Learning, Spacecraft Operations, Image Processing, Remote Sensing

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Kyle Hundman, Valentino Constantinou, Christopher Laporte, Ian Colwell, and Tom Soderstrom. 2018. Detecting Spacecraft Anomalies Using LSTMs and Nonparametric Dynamic Thresholding. In KDD '18: The 24th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining, August 19–23, 2018, London, United Kingdom. ACM, New York, NY, USA, 9 pages. https://doi.org/10.1145/3219819.3219845

Feruglio Lorenzo: Doctoral Thesis: Artificial Intelligence for Small Satellites Mission Autonomy. Politecnico di Torino, Italy http://hdl.handle.net/11583/2694565

Antarctic winterovering in terrestrial space analogues: cultural differences in emotional expression

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Background. Terrestrial space analogues, among them Antarctic stations, play an important role in the investigation of psychological adaptation to isolated, confined and extreme (ICE) environments. In the research on the emotionality and group dynamics with advancing time of isolation, a salient issue is the Third Quarter Emotional Dysphoria, characterized by a nadir of mood in the third quarter of the mission. Results of empirical studies are equivocal; a large variety of different measures were used in different settings and focused cross-setting comparisons are still lacking. In an earlier study, we used word-based content analysis with the LIWC software (Pennebaker, Booth, Boyd, & Francis, 2015), and found the Third Quarter Phenomenon in the French and Italian Concordia Station, but not in the British Halley VI Station (Ehmann, Altbacker & Balázs, 2018).

Aim of the study. The aim of the present study was to clarify the underlying reason of different emotional patters of Concordia and Halley crewmembers – i.e. the nature of cultural differences in emotional expression – by qualitative analysis. Method. 14 crewmembers of Concordia and 8 crewmembers of Halley VI stations were included. Ten-minute-long video diaries, collected on a weekly basis, were transcripted verbatim, and the French and the Italian diaries were translated into English. The diaries were separated into sentences, and Excel spreadsheets were used for qualitative coding. The final coding system worked with four code types: Self-Focus and We-Focus, both distributed to OK and Not OK, respectively.

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These four code types amounted up to two-thirds of sentences; the non-relevant codes were omitted from the present study. The nearly eighty thousand sentences were coded by 4 coders. Results. The results of this analysis have corroborated the automatic word-based content analysis with the LIWC software: the Third Quarter Emotional Dysphoria was present in Concordia also here. However, British diarists expressed much less negative statements about their teammates than their French and Italian counterparts. The Third Quarter phenomenon appeared saliently, but only in the rate of Self Not OK sentences, and not in the references to the group.

Conclusions. The sentence-based qualitative analysis shed light upon the phenomenon that British diarists are less apt to use directly negative statements in these contexts: it was able to show that negativity is present, but the linguistic markers are different. Our results may provide better insight into the emotionality of crews working in ICE environments both in the Earth and in the Outer Space.

Keywords:
Space Analog Environments, Isolated Groups,
Emotionality, Content Analysis, Qualitative Analysis

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Area classification and change detection from a time series of remote sensing images by using fusion Markov Random Field model

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Change detection on images of very different time instants from remote sensing databases and up-to-date satellite born or UAV born imaging is an emerging technology platform today.

Since outdoor sceneries, principally observation of natural reserves, agricultural meadows and forest areas, are changing in illumination, coloring, textures and shadows time-by-time, and the resolution and geometrical properties of the imaging conditions may be also diverse, robust and semantic level algorithms should be developed for the comparison of images of the same or similar places in very different times.

Earlier, a new method was introduced which applied unsupervised or partly supervised clustering on a fused image series by using cross-layer similarity measure, followed by a multi-layer Markov Random Field segmentation.

Here we demonstrate the capability of fusion-Markov Random Field (fMRF) modeling architecture in finding changes in fine textured image details or patch-based similarity analysis.

This lecture shows the effective parametrization of the fusion MRF segmentation/change detection method for the analysis of agricultural areas of fine details and difficult subclasses.

Keywords:
Markov Random Fields, satellite imaging, Earth observation, change detection, segmentation

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Asteroid deflection with solar sail and laser-based techniques

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Unbelievable, but hundred tons off asteroids burn in our atmosphere day by day. Most of them are small, only few gram kilograms, but there are bigger ones which could be hazardous. In 2013, a relatively small asteroid (20m in diameter) which exploded at the height of 30km over Chelyabinsk could cause a cost of 33-million-dollar damage in buildings in a sparsely populated area of Siberia. One can imagine what happen if a bigger asteroid explodes or impact into a densely populated area. This is one of the reason why different space agencies started to investigate more and more money on asteroid impact avoidance. For example, the European Space Agency works in this topic under the framework of the Space Situational Awareness optional program.

There are different techniques for asteroid deflection. We can divide these techniques into two groups, the nuclear and the non-nuclear ones. There are several international agreements which ban nuclear weapons from the space, so we started to examine the non-nuclear opportunities. In this work, we propose a new deflection method which is based on combination of the laser deflection and the solar sail [1] [2]. In our system, we will utilize a lot of small solar sails deployed on the surface of the asteroid, and we will increase the deflection power with laser beam. We not only present the system architecture but we show related calculations which are based on real asteroids' parameters.

Keywords:
asteroid deflection, solar sail, laser technology

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Astronomy clubs for extracurricular activities in schools

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Astronomy is not a subject included in the framework plan, in Romania, for that reason we decided to keep our students' interest high leveled by creating an Astronomy Club and inviting them to be part of different activities: World Space Week, Global Astronomy Month, Asteroid Day, Science and Technology Summer Schools or different national contests that have Space or astronomy as topic. Our Astronomy Club has the support of Societatea Astronomică Română de Meteori (Romanian Astronomical Society of Meteors- http://www.sarm.ro).

Keywords:
Astronomy Club, extracurricular activities, Space Education

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https://asteroidday.org/
https://www.unawe.org/
https://www.worldspaceweek.org/
https://astronomerswithoutborders.org/

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Astrophotography in physics class

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I would like to present an educational good-practice project based on astrophotography. For students, since the compulsory curriculum (Romania) does not include astronomical topics, it is always interesting to hear about space or the universe. Over the past few years, I have tried many different methods, integrating different topics into my physics lessons or project week assignments. One of the most effective methods for high school students was the introduction to astronomy and astrophysics, using astrophotography. The photographs are taken with students during Science camp activities and then the camera data are used to calculate the physical characteristics of the celestial body. During the Project Week or Astronomy Day programs, students make targeted observations with telescopes and take photos of the moon or the sun. Later these photos are used to teach Kepler's laws, rotational motion, or other mechanical or magnetics topics or for student-research projects. Students who participated in such projects successfully participated in student sc ence conferences or international competitions.

Keywords:
education, good-practice, astrophotography

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AstroQuizNight – An event where space doesn't part us but connects us

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AstroQuizNight is an astronomy and space activities related quiz night. These kind of activities in the field of science communication are simultaneously educative, entertaining and connect people with the same interest both professionals and simple enthusiasts. First it was started as a pub quiz but after six successful events it's shaping into a more likely TV quiz show form - or at least as I hope. The latter is probably much better for knowledge dissemination so in the future I want to tune the mood of it into something similar.

I'd like to present the methodology, the structure of such a night and the experiences from the previous quizzes in detail. I will show the whole process from the birth of the idea through the market research, creating the design, advertising, event management, hosting and showmanship to impact studies. The average 40 participants of these events are great indicators of that these events are perfect place for professionals and enthusiasts to network and meet in a much more informal way. In a long view these type of events can bond the enthusiasts to their possible future profession and then these can prevent them from burn-out, in both case this can make the sometime overwhelmingly monotonous or exhausting work bearable.

Keywords:
science communication, knowledge dissemination,
PR activities, space in pubs

References:
Promo movie:
https://www.youtube.com/watch?v=vYlsk8Bjeec
Facebook event of the last AstroQuizNight:
https://www.facebook.com/events/2214623848840403/

Automated and Remote Controlled Satellite tracking station

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In 2018 a small group of students and teachers decided to build an automated satellite tracking antenna.The project quickly outgrew itself, and became something bigger. Under less than 6 months we built a whole new antenna station with various antennas, and a laboratory to the peak of our city, to the tower of our university.

Our main goal is to participate in international projects and researches in satellites and radio astronomy. In our presentation we'd like to show how to build and manage an infocommunication system which is designed to work with satellites, and capable of having radio astronomy and space exploration researches on it.

keywords:
ground station, satellites

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Complete 3D coseismic deformation field reconstruction of 2019 ridgecrest earthquakes based on Sentinel-1 TOPS data

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One of the advances of Sentinel-1 SAR data, that it gives an outstanding opportunity to conduct in-situ mapping of large scale deformations due to the characteristics of the technique, as well as its open access policy and short revisit time. After the requisite calibrations and corrections (radiometric, terrain), geocoding, coregistration and phase unwrapping, the unwrapped phase can be converted to Line-of-site (LOS) displacement. Although it gives a characteristic picture of the investigated phenomena in one-dimension, but to obtain tree-dimensional (East/ North/Up – ENU) deformation, requires a more complex approach.

To obtain the true tree-dimensional displacement, both ascending and descending LOS displacements shall be retrieved. As well as, the corresponding unit-vector of LOS look-vectors and its parallel, along-track azimuth vector in the direction of the azimuth offsets, from the SAR sensor to all measurements (pixel) in ENU format. This lead to four observations with different incident angles for each measurements, which can be generalized as an over-determined inverse problem. The estimated model vector of the complete tree-dimensional displacement can be obtained, if the Jacobi-matrix can be represented as the look-vectors in ENU basis and the observation vector as LOS deformations acquired from the unwrapped phase of the interferogram. Then the over- determined linear equation system can be solved in the L2 norm via the Gaussian Least Squares (LSQ) approach combined with Singular Value Decomposition (SVD). [Wegmüller et al., 2016]

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Thus, to demonstrate the aforementioned, I present the continuation of DInSAR results of the two strike-slip earthquakes between 2019.07.04-06. with foreshock M_{WW} = 6.5 and mainhock M_{WW} = 7.1 in the Eastern Californian Shear Zone near Ridgecrest (US), which preliminary results have been already presented in the 2019 Space Academy of the Hungarian Astronautical Society.

Keywords:
Ridgecrest Earthquakes, InSAR Coseismic Deformation, Sentinel-1

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Wegmüller U., Werner C., Strozzi T., Wiesmann A., Frey O. and Santoro M. (2016). Sentinel-1 support in the Gamma Software, Procedia Computer Science, 100: 1305-1312, doi:10.1016/ j.procs.2016.09.246.

Current state of the free-space quantum key distribution

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Quantum cryptography introduces communication security in the physical layer, and therefore differs profoundly from currently employed conventional cryptographic techniques, which operate via algorithms running in the data layers [1]. Despite the fact that several quantum cryptography primitives are currently being investigated, quantum key distribution is the first one to have been experimentally demonstrated and the most technologically mature, as well the only one for which commercial systems are available on the market.

QKD exploits quantum physics to allow two legitimate parties to share a private key that is subsequently used to encrypt a confidential message to be transmitted along a public classical channel. The key is ensured to be private since it is transmitted along a quantum channel in a way that makes any eavesdropping attempt apparent to the legitimate parties. It is important to note that an existing optical link cannot automatically be assumed to be compatible with a QKD protocol, since in general it includes devices such as optical amplifiers, routers, and transceivers, which destroy the information encoded in quantum states. This is why several researches started in the free-space domain [3]. In another words, establishing direct connection between two nodes with optical cable might not be possible, due to geographical separation. In free-space QKD, the nodes are not fixed to work in one pair. After the secret key is established between two they can turn in other directions. This area is further important for satellite communication which is an absolute necessity for building a global quantum encryption networks [4].

* corresponding author

In our short study, we introduce the different types of QKD approaches (prepare-and-measure; entanglement) which can be used to generate secret keys between communication parties. We detail how the related main protocols work. As main part of our survey, we summarize the important past and actual QKD achievements in different countries in the free-space domain. The list of the countries which are part of our study includes Austria, Australia, Singapore, South Korea and many more.

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

Keywords:
quantum communication; quantum key distribution; satellite communication;

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Deformation monitoring using persistent scatterer interferometry and open-source software

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Satellite based surveying techniques have seen an enormous rise in popularity since the first GNSS signals became available for public use. A somewhat lesser known, albeit relatively old subset of these approaches comprises of spaceborne imaging radar sensors. While this kind of measurements has been around since the 1980s, it was the readily and publicly available datasets provided by ESA's Copernicus programme that brought the technique to the forefront of Earth observation sciences. With the launch of Sentinel-1A in 2014 and its follow-up satellite, Sentinel-1B in 2016, the public has free access to a library of high-quality imaging radar products with a revisit period of approximately six days. Apart from polarimetry and vegetation classification, with the help of interferometric processing techniques (InSAR, PS-InSAR), we can also use these products to extract deformation information in urban areas, or where so-called persistent scatterers are available.

The Department of Geodesy and Surveying at BME has always strived to utilize and incorporate cutting edge surveying techniques into its educational profile. In this paper – and the related poster presentation – we would like to present the outlines of a possible new course focusing on deformation monitoring and the extraction of movement information from Sentinel radar images using persistent scatterer interferometry (PS-InSAR). As the necessary datasets and tools are either provided by ESA (SNAP) or are available from open-source projects (StaMPS), we believe that the presented processing techniques can provide a valuable source of large-scale deformation information for anyone involved in the fields of surveying and remote sensing.

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Keywords:
radar, InSAR, PS-InSAR, education

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Demonstrational remote sensing payload development for high altitude platforms

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Remote sensing applications became more and more significant in recent years while providing crucial information about vegetation, open water surfaces, weather, water cycle or atmospheric parameters. Typical remote sensing platforms are satellites orbiting Earth covering large areas. In special applications like monitoring agricultural areas UAV-s and small planes can also be used. While they cost less and have better modularity, these platforms can only cover relatively small areas.

High altitude platforms are available solutions to cover larger areas in a cost effective way while higher operation altitude can provide opportunity to measure parameters that common manned or unmanned air vehicles cannot do.

The UPRA (Universal Platform for Robotics and Aerospace) High Altitude Balloon Team is developing a remote sensing payload for demonstrational and educational purposes. A prototype of a multi- spectral camera (UPRACAM) has been manufactured and flight-tested last year through five successful missions as part of an excessive test campaign. The team gained valuable experience in operating the scientific payload and demonstrated the capabilities of the UPRA high altitude balloon platform and proved that it can be used for remote sensing applications.

The UPRACAM is fully developed in house by UPRA team and take images in the visible and in the near infra-red range. Using the data collected by the device, observations on the vegetation and open water surfaces can be made providing useful information in the agricultural field, following deforestation and collecting data on flood or in-land water. The current prototype taking wide angle pictures which covers a larger area but gives smaller spatial resolution. Using image processing methods to

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create NRG false color and NDVI color composite images is a great hands on experience for university students, who are interested in automated image processing.

Previous design of the camera stored images on-board which are available only after landing by downloading as part of post-flight analysis. Our recent design of UPRACAM is capable of transmitting image files via radio during flight. To achieve this goal the internal communication of the UPRA platform had to be upgraded to allow the connection of external payload. This extension also allows collecting housekeeping data of the remote sensing device and sending camera configuration commands to UPRACAM.

This development provides the opportunity for the ground operators to find and set the best camera parameters during flight making regular remote sensing missions more reliable in image quality.

Keywords:
Remote Sensing, High Altitude Balloon, Earth Observation,

Deployment of the Hungarian E-GNSS Network and the results of its first year of operation

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Global Positioning System (GPS) is widely applied in numerous fields nowadays. Modern people can hardly find a location without a smart device having GPS navigation. In aviation, the significance of global positioning is increasing, even though, in the landing phase, it had been not so widespread formerly especially due to the low integrity of GPS itself. In addition to the American NAVSTAR GPS, further systems are operational at the present time, like the Russian GLONASS, the European Galileo or the Chinese BeiDou. State-of-the art devices can track all these systems; consequently, they measure 40+ satellites or even more at the same time. The number of satellites is expected to increase in the future. For safety critical applications of global positioning, providing sufficient integrity is of utmost importance. This can be achieved by using either Ground Based Augmentations Systems (GBAS) or Satellite Based Augmentation Systems (SBAS).

When relying on the consolidated results from several constellations of base and augmentation systems together we speak about the Global Navigation Satellite System (GNSS). E-GNSS stands for European GNSS, which is in the focus of scientific research these days when GALILEO becomes very close to its full operational state, meanwhile the EGNOS (European Geostationary Navigation Overlay Service) Safety of Live service was officially declared available for aviation in 2011.

Following the strategy of the European Union, satellite based instrument landing approaches have been introduced at a great number of aerodromes all around the European region. Hungarian procedures for seven civilian and three military airports are

being designed and published within the framework of the PBN4HU (Implementation of PBN procedures in Hungary) project granted by a INEA (innovation and Networks Executive Agency) programme.

Besides the procedures, the Hungarian E-GNSS monitoring network was also deployed within the framework of this project in 2018. The most important aim of the network is to monitor the performance of the EGNOS augmented positioning and gain the experience necessary for the application of GNSS in navigation. The network consists of 11 stations equipped with the most modern triple frequency, Galileo capable receivers. Raw measurements are recorded with one second sampling interval and post processed in a full automatic way on a daily basis in accordance with ICAO (International Civil Aviation Organization) standards and requirements. Spectrum analysers are also installed at the stations to monitor all the three carrier frequencies in order to detect and report interference events.

Doctoral school in geospatial science in Uzbekistan

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Geospatial Science (GISc) provides the theoretical foundation of handling geo-related (ie. Spatially referenced) digital spatial data acquired primarily by satellite-borne methods by integrating three traditional geosciences: geodesy as the science of precise spatial data acquisition, geography as the science of studying human and physical aspects, cartography as the science of making maps. As a result, GISc delivers an essential tool for interpreting, visualizing and analyzing measurements of Earth Observation satellite missions, such as Remote Sensing. It makes use of the methods of geospatial analysis and modeling, information systems design, geocomputation and geovisualization.

With the coordination of the Óbuda University, an Erasmus+ Capacity Building in Higher Education, Key Action 2 project named Doctoral Studies in GeoInformation Sciences (abbreviated as DSinGIS) is conducted. The wider aim of the project is to support Uzbekistan in sustainable development by GISc. The objectives envisaged with the project is to establish a missing puzzle from the Uzbek educational system after the MSc level has been completed and before the DSc is targeted. The project established an accredited Doctoral School in the field of GISc, developed its programme, defined the requirements, advanced supporting teaching and learning materials in English or Uzbek languages, all developed in accordance to international standards and in accordance to the Uzbek education system.

As a support for the new Doctoral programme, a network of activities is conducted to improve the educational and research capacity of the Uzbek society. Among these activities, an international network of the 5 leading Uzbek universities is established.

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Also, their education capacity is developed by creating a Knowledge Center at each Uzbek universities containing an e-learning platform with a jointly developed knowledge pool. Furthermore, a Joint Research Centre, a research lab is developed to improve the research capacity of PhD programmes. A glossary of geospatial terms was introduced, containing definitions in Uzbek, helping interdisciplinary communications. Finally, annual GI conferences are organized to provide a platform for presenting research results.

Keywords:
Geospatial Science, Doctoral School, Uzbekistan

Education and outreach activities in Bükk Starry Sky Park

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International Dark Sky Park award can only be given to state owned, protected areas, where light pollution level is at a low level. Bükk Starry Sky Park was recognized by International Dark Sky Association (IDA) in 2017. An other important role is to involve people who are interested in nightlife, astronomy, and the wonders of the sky. Starry Sky Parks play a very important role in science promotion. The Bükk Starry Sky Park is the 49 th park in the world, and 3 rd among Hungarian dark sky parks. This recognition not only guarantees the undisturbed longevity of the nightlife, but also helps astronomical observations, and extend our outreach and education programs in darkness. We made a big tangible and demonstrated step forward to fight against light pollution. Lot of lighting fictures were replaced and demonstrated to hundreeds of students in our visitor center. From here you can see curiosities with naked eye such as zodiac light, as well as the milky way. These phenomenons are not visible at all from light polluted cities and habited areas. It also creates great opportunities for astronomical observations. During the hall year, visitors take part in a number of stargazing nights with telescopes. These evenings are organized by the Bükk National Park Directorate, the local association (Hive Stone Conservation and Culture Association), Eszterházy Károly University, the national park directorate, and the association's several years of work, surveys, data collection had to be done in order to prepare the submission material. Our short and medium-term plans include the establishment of an astronomical visitor center, which helps to spread knowledge, and can be integrated into international research programs.

Keywords:
starry sky park, dark sky park, light pollution

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ESA perspective on lunar surface exploration and resource utilization

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The European Space Agency continues the development of several projects towards the Moon. PILOT[1] the equipment enabling precise and safe landing on-board the Russian Luna-27 lander by providing absolute and relative navigation and hazard detection and avoidance functionalities is completing Phase B. PILOT-D, an early demonstrator of the PILOT landing camera on-board the Russian Luna-25 lander, has completed testing of its Flight Model.

PROSPECT[2], also embarked on Luna-27 as a surface payload, will take samples from the lunar regolith and its on-board 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). Water on the lunar surface will be one of the first resources that could be potentially utilized to sustain a permanent human presence on the lunar surface.

Following the Ministerial Council in Spain in December 2019, ESA intends also to conduct a feasibility study of a European Large Cargo Lunar Lander, which will rely on the lunar Gateway to establish an access to and return from the lunar surface. [3]

Further ISRU missions are now being studied to utilize lunar regolith as building blocks of a human settlement.[4] These studies are investigating the use of additive manufacturing with lunar regolith. ESA is now investigating an end-to-end demonstration, which would demonstrate the production of oxygen on the lunar surface in the coming few years.[5]

Keywords:
Moon, ISRU, robotic exploration

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Establishment of the hungarian space engineering curriculum

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At the more than two centuries old Budapest University of Technology and Economics (BME), several researchers and development engineers pursued their education or work who attained world-class achievements in the area of modern space research. The different lessons learned of these projects became educational content for the next generation of students. Currently, there are about 20 courses at 4 faculties in the space domain on undergraduate and graduate level [1].

Although our students and staff members participate national and international space projects, it is not easy to recognize their achievements from educational point of view since aerospace engineering or space engineering curriculum does not exist in Hungary. Fortunately, several stakeholders raised the need for such a degree in the past years. Informal discussions were initialized by Hungarian Astronautical Society (MANT) in 2016 [2], and BME started to push further by harmonizing its internal space related educational processes [3]. In 2019, the BME Faculty of Electrical Engineering and Informatics initialized a process which will lead to the establishment of the space engineering MSc curriculum in the country. If the curriculum is established, every Hungarian university which has the necessary competences can start a space engineering program for their students. We plan a two- year Master course which will cover the most important aspects of space engineering.

In this paper, we overview the space relating educational and research activity of BME, we outline the establishment process of the Space Engineering curriculum and the planned structure of the education.

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Keywords:
space education, space engineering

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Evaluation of the space debris environment and active removal optoons based on drag-sails and electrodynamic tethers

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Since the beginning of our space age, over 8000 satellites have been launched. Most of those satellites decayed to space debris and now revolve around earth on uncontrolled and partially unpredictable orbits, posing a substantial collision risk to operational spacecraft. Especially the announcement and beginning of the implementation of megaconstellations has been controversially discussed in the context of space debris. Already the current space debris situation poses a threat to future space activities. As a reaction to this issue, ESA has announced a space debris action plan within its last ministerial meeting.

The proposed paper therefore aims on the characterization of the current space debris situation, as well as presenting an outline and a quantitative comparison on methods of active debris removal. To characterize the current debris situation, it is evaluated using the available tracking databases including the european DISCOS. While searching for methods suitable for active debris removal, passive deorbiting methods as a possibility for harvesting energy in orbit have been discussed. As most promising methods, electrodynamical tethers and drag enhancement devices were studied. Due to their different operating principles the above-mentioned methods have distinct deorbiting characteristics. Especially performance over altitude is a heavily varying parameter due to a strong atmospheric influence in case of drag enhancement devices. To provide a fundamental comparison between drag enhancement devices and tethers, an evaluation based on the statistics of the debris distribu0on is performed to quantify the influence of the different devices and their dimensioning on the deorbiting trajectory.

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In order to augment the performance of a deorbiting device, combinations of different approaches are evaluated and an optimization for different flight strategy is presented. Flight strategies are especially interes0ng for drag enhancement devices, since their operating principle is affected by their orientation: By exposing a larger effective cross section area, a captured target becomes more sensitive to atmospheric drag as well as solar radiation pressure. Since the resul0ng forces are acting in different directions, a flight strategy which is optimized on radiation pressure requires a different AOCS strategy. Concluding the investigated aspects, an overview of the different deorbiting configurations performance for different orbital energies and target masses is provided.

Keywords:
Space debris, active debris removal, on-orbit servicing, tether, drag-sail

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From the torsion balance to space gravimetry

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In 2019 we commemorated the 100th anniversary of the death of Loránd Eötvös. Up to the 1960s, his famous torsion balance had been used for detecting the unevenness of the gravity field, even in industrial activities. Students may ask what devices are used to make these measurements today, a hundred years after Loránd Eötvös. As an answer to their question we may tell them that nowadays the gravity field of Earth is measured with the help of aircraft and satellites. In the meantime, a new field of science was also born, namely, Space Gravimetry. A world-renown expert of this field was Imre Izsák, whose work is also worth mentioning in class, since he was the one who first made calculations about the shape of Earth based on satellite measurements hence gaining reputation as an internationally recognized scientist.

The Gravity Recovery and Climate Experiment-Follow-On (GRACE-FO) twin satellites, successfully launched on 22 May 2018 and they examine the gravity field of Earth with the state-of-the-art laser interferometry technique. The tiny gravity anomalies of Earth can be tracked by measuring the changes in the distance between the two artificial satellites. Nowadays, the use of Arduino micro controllers in Physics classes has become more and more popular. My students, for example, applied them to create a simplified version of GRACE-FO twin satellites' measurement method. The models of the satellites were designed by one of my fourteen-year old students, who 3D printed them with the help of some imaginary online drawings. Similarly to the original procedure used in space, distance measurement in class was also carried out by laser. Simultaneously, the results could be demonstrated on a graph with a program. With this experiment it is not only possible to bring space research closer to our students, but we can also show them how these measurements can contribute to the research on e.g. climate change if we use additional online sources in connection with theoriginal measurements.

Keywords:
Space Gravimetry, GRACE-FO, ARDUINO, 3D printing

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Investigation of new methods in the education on the field of space communications and space research

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The conquest of space and the introduction of new technologies are becoming more intensive at the international level in these days. New sensations are coming to conquer space every year. (Tesla in space, landing on the Moon's other side, etc.) International competition is intensifying, but what is our role? Will there be any Hungarian expert, engineer, lawyer who is participating in this competition representing our country?
"Never be afraid to do something new! Remember, a lonely amateur man made the barge and a bunch of experts the Titanic"
Miklós Vámos

The first Hungarian satellite was built by enthusiastic students and teachers at the Technical University of Budapest. They had gained a wealth of experience and experts who were able to participate in international space projects. What's the secret to their success? Can their model be adopted, and this success repeated? In our presentation we are looking for the answer. Following the example of BME, the University of Győr took its first steps towards space communications in the second half of 2018. The agile methodology had been experimentally included among the teaching methods. Agile methodology is very popular and successful today in the field of information technology. The traditional view is that resource requirements are determined based on the goal to be achieved, but the agile methodology is the exact opposite: time and budget determine the task to be done. By May 17, 2019, a volunteer group of students had wanted to build a ground station. After an accurate understanding of the geographic and technical characteristics, the financial resources that could be involved were mapped. In the light of these, quick decisions were made on the available targets until May 17,

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2019. It involves tracking the second Hungarian satellite and communicating with satellites in a geostationary orbit. Conceptual systems engineering had been designed to be developed and allow for new student goals. It should be noted that students could have bought several tools, solutions at the ready, but the sponsors saw the young enthusiastic creators willing to learn from their mistakes to make their own inventions. It is characteristic of the organizational structure of the group that it is based on the self-organization of the students and their leader is also a student. Two teachers follow the group's professional work and intervene in the group's internal operations only when necessary.

The University of Győr has the capability of having an institution (Mobilis http://mobilis-gyor.hu/) right next to it where young students can acquire science skills in a playful way. University students realized this opportunity and became involved in summer camps. In 15 groups, they handed over the knowledge they gained in their project work to the younger ones. It was a special task for the university students to find the methodology by which the younger ones could be approached and attractively introduced to the field of space research.
We would like to share our experience and future plans with the conference participants.

Keywords:
space communications, education, methodology

IRSEL: Innovation on Remote Sensing Education and Learning

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The EU space strategy in the document "2016 Communication on a Space Strategy for Europe" fosters the uptake of space techniques applications. "The Commission's aim is to optimise the benefits that space brings to society and the wider EU economy. Achieving this means boosting demand among public and private users, facilitating access to and use of space data, and stimulating the development and use of innovative downstream applications." The demand is in line with the practice observed in the field of Remote Sensing (RS), which has wide range of potential applications unused. With the coordination of the Óbuda University, an Erasmus+ Capacity Building in Higher Education, Key Action 2 project named IRSEL is conducted to foster the uptake of RS applications to boost the benefits that space brings to society and the wider economy, focusing on Thailand and China. The objective of the IRSEL project is to develop an innovative learning platform, a Learning Management System (LMS) for Asian countries, China and Thailand. Though the content of the proposed LMS would not correspond to any level of tertiary level education, it is basically planned to be developed for meet MSc standards to BSc of related disciplines to RS. Beyond establishing the LMS at each Asian university, a Knowledge Pool of high-level e-Learning teaching materials for a wider scientific and engineering community is developed, furthermore workshops, trainings for the teaching staff and a summer school for selected students are organized.
The LMS proposed at 4 Asian universities will serve the practical applicability of increasingly higher resolution remote sensing data coming from more and more sources for wide range of disciplines (including different tasks of Environmental protection, Agriculture, forestry and fishery, Physical sciences, Engineering and engineering trades, Transport services, Security services).

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Local ionosphere modelling with GPS in Hungary

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The ionosphere plays great importance on radio propagation due to the fact of dispersive medium distorts the electromagnetic waves, causing refraction. Global Navigation Satellite System (GNSS) broadcasts signals in L-band frequency, which travel through the ionosphere, causing delays in code and advances in phase measurement. Mitigating this effect is essential to achieve high-performance positioning. Modeling the ionosphere is in priority not just for the single- but for dual-frequency receivers in case of high integrity requirements. The Total Electron Content (TEC) of the ionosphere is a key parameter for describing its state. This paper presents an algorithm to derive a TEC map from double frequency code and phase measurements. This station-based algorithm fits well for one station or a smaller countrywide territory but could be scaled up to a larger local area, like continental Europe. EUREF Permanent GNSS Network provides reliable data to derive the slant TEC values, biased by the receiver and satellite hardware delays.

The biases can be considered constant for a given day and estimated by least-squares adjustment. After the adjustment, vertical TEC values are calculated at the ionospheric piercing points. In the last step, the TEC values are interpolated to form a regular grid, thus create a TEC map. Gaussian process (or Kriging) is well suited for this interpolation not just because of the high performance, open-source algorithms coming from the machine learning field, but its unique property to naturally estimates the solution space's covariance matrix. The variances provide information about the quality of the TEC map, and from the covariance values, one can gain insight into the state of the ionosphere. This paper describes this algorithm in detail and shows its benefit.

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Keywords:
GNSS, Ionosphere, TEC map, Ground-based measurements of ionosphere

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Martian climate database – an online tool to model the red planet

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The atmosphere of Mars is a complex system, governed by specific physical, dynamical and chemical processes. The climate of the planet is quickly changing due to the diurnal and seasonal cycles combined with extreme and various topographical features. The Mars Climate Database (MCD) is derived from the numerical simulations of the General Circulation Model (GCM) developed at Laboratoire de Météorologie Dynamique du CNRS (Paris, France) in collaboration with the Open University (UK), the Oxford University (UK) and the Instituto de Astrofisica de Andalucia (Spain) with support from the European Space Agency (ESA) and the Centre National d'Etudes Spatiales (CNES). It is freely distributed and intended to be used in relation to engineering applications and scientific studies requiring precise understanding of the Martian atmosphere. The MCD is available through request as an offline tool, as well as there is an easily applicable web interface, where we can not only calculate, but download data and readily made figures as well. The online tool is diverse, highly customizable and comes with a number of presets ready to use. It is a great and simple interface suitable for education, student projects and research tasks to get familiar with climate modelling. In my presentation I demonstrate the usage, a selection of possible outputs and the way of how we implement this database in our research.

Keywords:
Mars, Climate, Modeling, MCD, Online

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Mouse-on-the-Mars and other developments with secondary school students

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In the last few years my group worked on SiPM (silicon photomultipier), we characterized thousands of them. Since these are sensitive to radiation, the effects of radiation damage from gamma rays have been measured and compared with the damage produced by neutrons. During these tests we developed several different PCBs and readout solutions. In the next few years we will develop an easy-to-use, autonomous scintillation detector based on the experiences of SiPM readout electronics. These will be a multichannel solution for space application, but the single channel can be a cost-effective detector for secondary school students. They can build the detector and operate for a while to have experiences with the background radiation.

Since 2017 dozens of students from the local secondary schools were mentored by this group. The started with cosmic ray detectors and smoke detectors (PM2.5, PM 10), this year half of the students will work with this one channel scintillation detector. Other half of them will work on the mouse-on-the-Mars project. They plan and develop a greenhouse (with CO_2, temperature, humidity… sensors, LED lamps and heater/cooler) that can feed a mouse and can cover the O_2 for it. By scaling up this greenhouse they can imagine what astronauts will need for years long Mars expedition. During this project they need to talk with experts from agricultural and food science to find the best combinations of plants for it.

Keywords:
scintillation detector, greenhouse, astronauts

Pioneer chemical formulation experiments on ISS

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In the history of space research, we have come to the time when space chemistry and its applications (i.e., performance of chemical syntheses and formulations in space, and structural investigations for macromolecules) become important for the advancement of space technologies, so as for chemical and pharmaceutical industries on Earth.

For the first time in history of Elon Musk's SpaceX, a Hungarian company called InnoStudio with a research group from the Budapest University of Technology and Economics and the Research Center for Natural Sciences (Biostruct Lab) are participating in the scientific mission launched on the 5th December 2019 to the International Space Station (ISS) and supported by their collaborative partner Japan Manned Space Systems Corporation (JAMSS). In frame of the experiment, a novel chemical formulation/crystallization equipment of JAMSS including chemical samples of Innostudio and protein samples of the research group were launched. The demonstration equipment was installed in the ICE Cubes Facility located in the European Space Agency's Columbus module.

By the microgravity experimentation, validation of one of the space chemistry related patents of InnoStudio and creation of novel nanostructures in space are expected. To the best of our knowledge, so far, no other research on small molecules co-crystallization in space has been reported. Results of the experiment will contribute to better understanding of chemical formulation processes in space and will supply initiative data for ma-

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king chemical syntheses in space possible. The performed experiments may furthermore lead to the development of novel formulation ways for diverse chemicals. As for the protein samples, being potential drug targets of various cancer types as well as of widespread epidemic diseases, their better quality and better ordered macromolecular crystal structure formulation is expected in space, which will allow more precisely targeted drug design.

The aim of this presentation will be to give an insight to the project including preliminary optimization experiments, applied crystallization technology, selected results and expected advantages for both the Hungarian and international space community.

Keywords:
space chemistry, chemical formulation, crystallization, drug design, microgravity

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Planetology aspects in university education of geography and environment

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The planned poster comprehends those aspects of planetology which are educated in geographical and environmental curricula of the University given in the heading.

The planetology related subjects will be classified into four groups:
(I) Basic sciences taught for the Earth with respect to our wider environment, the Universe.
(II) Science on the Earth with respect to the Solar system.
(III) Research methodology focused to the Earth but applicable for wider sense, in the Universe.
(IV) Earth-Space interactions: depleting resources of the Earth solved by the Space, potential risks for the Earth threatening from the Space.

Group (I) is represented by introductory and advanced courses in Mathematics and in Physics. Kinematics of the planets around the sun, i.e. the track along the ellipse, or laws of Kepler are often cited examples.

Group (II) is led by the Astronomical Geography, which deals both with astronomy of the Solar system and history of the Universe in detail. Further subjects, i.e. History of the Earth and the Life, General Geology and Earth History, or History of Geography and Earth Sciences help the students to see the processes in time as well as in synchronism with the human culture.

Group (III), teaching planetology related research methods, collects diverse subjects. Mineralogy and Petrology applies methods for elaboration of any known mineral in the same way as it should be done with any stone from the Earth. Environmental analytics teaches careful chemical operations to get information about the composition of the object in question.

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First side of Group (IV), Earth-Space interactions, is represented by subjects, which demonstrates which materials are we run out here in the Earth. Renewable Energy Sources points at the alkali Earth metals needed for devices of various renewable resources. Subjects of Waste Management, Reuse and Recycling point at obtaining these materials on the Earth. The rest should be found somewhere in the Space. The other side of this coin are the risks coming from the space.

Based on the above-mentioned qualifications, it is planned to open a new session in organizing international summer schools of the Planetary Sciences starting in August of this year. It is a purpose of this school to have introductions to Planetary Morphology, Meteoritics, Cosmochemistry, Meteoritics and Space Technology for the Planetary Missions as well. It is also planned to have several field trips during the week of the summer school to visit the Permian/Triassic Boundary, Astronomical Observatories, etc.

Keywords:
Earth, Solar System, Universe, geography, environment

Pneumo planet Mars habitat and moonbase

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The concept is based on a prefabricated inflatable structure with very little payload that can be erected on Mars or on the Moon. It is protected from cosmic radiation and micrometeorites by a thick deposit of lose regolith. Visible sunlight is reflected inside by a new system of mirror membranes to heat the habitat and for plants, that produce food and oxygen through photosynthesis. The particle radiation is not reflected into the habitat but absorbed in the Martian soil.

On Mars the best place for the habitat is near the equator while on the Moon it is on the poles, where sunlight is almost permanently available, is the best place. For the Mars Habitat the sunlight comes vertically in a 24,37 hours cycle, while on the pole of the Moon it comes horizontally and almost permanently. This is why the geometry of the building structure and for the mirror membrane needs to be different as well.

Unlike most of the other recently published concepts for Mars habitats, this design does not rely on 3D-print technology. It simply is not necessary to 3D print supporting walls and ceilings, because air pressure inside the inflatable structure can easily support several meters of regolith deposit and we have calculated, that the required energy to 3D print all these massive structures simply is not available on Mars with reasonable effort.

Since it takes 7 months to travel to Mars, any supply from Earth is very difficult and is not reliable in case of an emergency. Therefore the crew should have a self sufficient production of food and oxygen. All organic waste needs to be recycled. The use of natural Sunlight is more efficient and causes far less payload than LED light from Kilopower reactors and therefore should be favoured. The goal of this project is to replicate in a small scale a

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complete ecological cycle as we have on earth, including humans, animals, plants and microorganisms. The concept is patented and has been evaluated by the ÖWF (Austrian Space Forum) and other independent scientists. Therefore we can assure, that our concept is a novelty, that is works under real conditions from a scientific point of view, and that it features a lot of advantages to all so far published concepts of habitats for the Moon and Mars.

Information on the website: www.marshabitat.space
And the video documentary: https://www.youtube.com/watch?v=I-vDeK96tF8&t=335s

Precise orbit determination and prediction using GNSS and SLR observations

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The availability of precise orbit solutions with the accuracy of a few centimeters are necessary for numerous satellite applications, such as gravity field studies, precise positioning and near-realtime remote sensing applications. Although the International GNSS Service (IGS) provides ultra-rapid orbit solutions for both GPS and GLONASS navigation satellite systems, only a few analysis centers provide similar orbit solutions for the European Galileo satellites.

This paper introduces the precise orbit determination and prediction algorithm used for the determination of the Middle Earth Orbits of GNSS satellites at the Department of Geodesy and Surveying of the Budapest University of Technology and Economics. The developed system produces updated ultra-rapid satellite orbits four times a day based on 24 hours of global multi-GNSS observations of a subset of the IGS network. Furthermore, the products include an orbit prediction for an additional 24 hours using detailed models of the gravity field and radiation pressure model ECOM2 as well.

The results are validated using independent satellite laser ranging (SLR) observations. Since not all of the satellites are equipped with laser retroreflector arrays (LRAs), this validation was done for the Galileo and the GLONASS satellites only. To validate GPS satellite orbits, the ultra-rapid satellite orbit solutions are compared to the final orbit products of the IGS, too.

The derived precise orbit products enable us to include the newly available Galileo observations in the operational near-realtime GNSS processing system used for the estimation of atmospheric water vapor content in Hungary. These data sets are being used for improving the meteorological forecast of precipitation over the country.

Keywords:
precise orbit determination, satellite laser ranging, GNSS

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Radiation test facilities at Atomki and their space research applications

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Broad range of energetic ionizing and non-ionizing particles and different radiation test facilities and laboratories are available at Atomki for space research applications. Radiation damage effects induced by ionizing particles (gamma photons and charged nuclear particles) can be studied with

$E_{\gamma 1}$ = 1173 keV and $E_{\gamma 2}$ = 1173 keV gamma photons emitted by a high intensity gamma photon source with ^{60}Co radioisotope

beams of E_p = 2.5 − 18 MeV protons, E_d = 1 − 10 MeV deuterons and E_α = 2 – 20 MeV α-particles accelerated by the MGC-20E cyclotron

beams of H^+-ions (200 − 4030 keV), He^+ and He^{++}-ions (200 − 6030 keV) and C, O, Si, Cu heavy ions at the Tandetron accelerator,

beams of several types of low energy (50 eV − 30*Q keV) heavy ions (from H to Xe) at theElectron Cyclotron Resonance (ECR) ion source.

Atomic displacement damage effects induced by non-ionizing particles (neutrons) can be studied at

a high intensity fast neutron irradiation facility that generates broad spectrum p+Be neutrons in the E_n = 0 – 16 MeV neutron energy range

an irradiation facility that produced quasi-monoenergetic d+D fast neutrons in the E_n = 0 – 12.5 MeV neutron energy range

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Atomki has participated and participates in several space research and development programs (e.g. ESA SMART-1 mission, Hugin and Monin satellites of the Swedish Space Corporation, EUROPLANET RI).

A cryogenic laboratory, laboratories for materials sciences, a laboratory for ion beam applications and a laboratory for electronics and detector development are available for simulating harsh cosmic environments and for studying many different problems.

Numerous results obtained with participation of Atomki groups have been published in many international conferences and in peer reviewed and referred international scientific journals.

Keywords:
irradiation testing; radiation damage; simulation of harsh cosmic environments; ion – ice interactions

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Radio Frequency Interference Monitoring at locations in Nógrád County

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Research stations receiving radio signals, such as for example astronomical observatories are extremely vulnerable to man-made radio frequency interferences (RFI). Selecting a suitable site is among the essential first steps when installing a new facility. Typical characteristics of a radio quiet location are: (1) reasonable shielding offered by the terrain surrounding the site; (2) a large enough distance from large cities; (3) a cooperation with local authorities and with the national frequency administrator. Last but not least an ITU registration may also help to avoid any future installation of electrically noisy sources too close by.
Given the local support by Nógrád County in Hungary, and that of the Hungarian National Media and Infocommunications Authority (NMHH), we started RFI monitoring measurements in mid-2019. These were performed it in the low populated heart of Nógrád using a state-of-the-art technology mobile monitoring vehicle of the NMHH. We present a summary of our results monitoring the frequency range of 40 MHz - 18 GHz. We discuss in detail all the RFI components and the careful calibration of their electrical characteristics. Our review also includes a description of our mobile monitoring vehicle, which is composed of a van fully equipped with high performance instrumentation (spectrum analysers, monitoring receivers, an extendable antenna mast, various types of antennae etc.) and their associated auxiliary devices (GNSS receivers, antenna pointing readouts, autonomous power supplies, etc).

Keywords:
radio frequency interferences, spectrum monitoring measurement, radio control and interference management

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Rocket technology for secondary school students

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A sounding rocket (or research rocket) is an instrument-carrying rocket designed to take measurements and perform scientific experiments during its sub-orbital flight. The rockets are used to carry instruments from 48 to 145 km above the surface of the Earth, the altitude generally between weather balloons and satellites; the maximum altitude for balloons is about 40 km and the minimum for satellites is approximately 121 km. [1] A good example is the sounding rocket series repeatedly used by NASA, called Black Brant.

We at the BME Cosmos Society [2], [3] ('BME Kozmosz Kör' in Hungarian) build a sounding rocket which can be used in the Hungarian CanSat Competition [4]. Our rocket is a solid-propellant rocket (fuel and oxidizer both are in a solid state), just like the one used in the European CanSat Competition [5] of ESA. It will be able to bring two CanSats to 1 km of height in 30 seconds and then return with its parachute (120 cm diameter) after releasing the CanSats. Two CanSats weigh about 700 g, the mass of the rocket is around 1.4 kg, thus a relative strong motor is needed, at least a 38 mm motor from the H class (according to the model rocket motor classification system). The rocket is made from a carbon-fiber material, it has a small mass compared to its strength. There is a metal aft part of course. The motor is reusable, the rocket operator team just needs to change the propellant stick inside of the motor and fasten it with the aft closure ring, then fasten it inside the engine with an engine retainer cap. It's easy to do it fast and efficiently on site. The nose cone has an ogive-shaped design, although it's not too efficient, but very easy to produce

As written above, this rocket is going to be an equipment for the Hungarian CanSat Competition. We have educational goals related to the competition: on the one hand we would like to gain knowledge about rockets, rocket launcher and organizing a nation-wide competition, on the other hand we would like to

bring the rocket technology closer to secondary school students. During the Competition the students can experience teamwork, meet new people with similar interests, and of course will have many opportunities to gain knowledge about technology. We hope that in the future this Competition will be the official National CanSat Competition of Hungary in the European CanSat Competition.

Keywords:
sounding rocket, solid-propellant rocket, rocket technology, education, university project, CanSat, Hungarian CanSat Competition

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Satellite images to support contribution of meteorology to the UN sustainable development goals (2016-2030)

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The General Assembly of the United Nations (UN) accepted the 2030 Agenda for Sustainable Development including 17 Sustainable Development Goals (SDG 2015) and 169 detailed targets. These goals spread over all natural, human and economical aspects of sustainability all over the world. The 17 established Goals are not ordered into any logical structure. We recommend a fairly unequivocal classification of the 17 Goals, as follows (i) Primary needs of humans (2. Food, 3. Health, 6. Water and 7. Energy), (ii) Equality between humans (1. No poverty, 4 Education, 5. Gender equality and 10. Reduced inequalities), (iii) Efficient, sustainable production (8. Economic growth, 9. Innovative industry, 12. Responsible consumption and production, 13. Climate action), (iv) Landscapes in danger (11. Cities, 14. Life in water and 15. Life on land) and (v) Worldwide cooperation (16. Peace and justice and 17. Partnerships).

The aim of our study is to present those Targets in which meteorology should play important role and to illustrate how satellite images are applied to support various activities of meteorology. 22 Targets are found to be relevant for meteorology, marked according to the four main branches of meteorology, requested to meet the challenges. They are air-chemistry, climate information, climate change and weather forecast. The most targets (18 from the 22) request climate information (CI). Climate change (CC) and weather forecast (WF) can be attached to 11-11 targets. A slightly smaller number, 9 targets can be supported by information on air pollution (AP).

For possibilities of satellite application the weather forecasts take the lead, mostly considering the observations for nowcasting purposes. Concerning air pollution satellite applications are somewhat limited by the resolution of operational satellites. Heavy tasks of climate change uses satellite information in rather variable ways. Climate information is still mostly

based on surface-based information, though the longest satellite information series is available, the higher share can be obtained for them even in this branch of meteorology.

Keywords:
sustainability, meteorology, climate, weather, air-pollution

References:
SDG (2015): United Nations Resolution A/RES/70/1, 25 September 2015. The Goals are in par. 51 (http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E)

Shielding optimization for the RM-RAD-S radiation monitor

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Space weather monitoring is more and more important not just for planning future space missions but for forecasting bigger events as well to protect humans in space, important satellites and terrestrial systems. The monitoring should include the interaction between the Sun and the Earth both with in- situ and remote sensing observations. Around the Earth, this means that a fleet of satellites is required to measure the magnetic field and charged particle environment in real time at several different points in ranges that are most harmful for space systems. For this, to be feasible, most of this should be implemented in the form of hosted payloads. That is why the Centre for Energy Research has been developing a space weather monitoring system called D3S-RadMag for the European Space Agency's D3S programme [1]. The instrument comprises magnetometer units (RM-RAD-S) and radiation monitors (RM-MAG-S).RM-RAD-S is a charged particle silicon detector telescope for measuring protons, electrons, and heavy ions. The first conceptual design of RM-RAD-S has recently been finished, but the optimisation of the detector geometry is still ongoing. Shielding is under optimization for both type of material and shape, which could even potentially change the exact location of the detectors. In this talk the current state of the project and the possibilities of optimization will be presented.

Keywords:
shielding, radiation monitoring, dosimetry

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Shoot an asteroid – linking laboratory based meteorite mineralogy to European space mission by university support

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Based on recent discoveries of near Earth asteroids with impact threat (Rudawska et al. 2019), initiatives for a possible asteroid mitigation action have been started. The Hera mission of ESA aims to analyze the Didymos double asteroid (Kueppers et al. 2018) after it will have been hit by the NASA DART mission. To better understand how different minerals of asteroids look like in the infrared region during the analysis by the mission, to support Hera and its two cubesats, meteorite sample analysis started at the RCAES (CSFK) institute in the middle infrared region, by the support of ESA (NEOMETLAB, 4000123143 project), the GINOP -2.3.2-15-2016-00003 project of NKFIH, and with the help of the Eotvos University.

During the work, regular laboratory facilities and mineral analyzing methods were applied, which aresimilar to those used at the MSC education of geology students at the ELTE University. The regularoptical analysis was completed with infrared DRIFT (Skulteti 2019, Skulteti and Kereszturi 2019), ATRanalysis, powder diffraction and some Raman measurements. As meteorites represent interior of asteroids, they give possibility for mineral analysis and composition determination of the source objects. During the work, main minerals were determined, as well as shock related observations were acquired (Rezes 2019)..

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The project demonstrates how university courses related laboratory methods could be applied in space missions, and support the better understanding of near Earth asteroids to prepare future mitigation actions.

Keywords:
laboratory analysis, ESA mission, meteorite, asteroid.

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SiPM based detection of cosmogenic production of radioisotopes in spacecraft substances

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Devices used in space are exposed to continuous radiation, so that over time, the radioactive material that accumulates in them would provide a significant background for sensitive experiments. Our goal is to build a detector system and associated simulations (Geant4) that can be remotely calibrated over time by detecting high energy MIP (minimum ionizing particle). For the detectors we will use plastic scintillators without and with various impurities (lead), which are connected to our SiPM based data acquisition system via a light-guide. Detectors placed in multiple layers at multiple positions allow for differentiation of rays from different directions.

The obtained production rates from Geant4-simulations can be used to predict the accumulation of radioactive isotopes in each substances and thus to calculate its cosmogenic activation. High school students will be involved in the processing of the plastic elements of the detector, so that they could become acquainted with the ins and outs of detector making.

Keywords:
sipm, plastic, cosmogenic

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Space weathering-related evolution of fine-grained asteroidal and cometary materials: sample return planetary missions

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According to Britt et al (2014), space weathering is a generic term for the effects on atmosphereless solid bodies in the solar system from a number of processes associated with direct exposure to the space environment. These include impact processes (shock, vaporization, fragmentation, heating, melting, and ejecta formation), radiation damage (from galactic and solar cosmic rays), solar wind effects (irradiation, ion implantation, and sputtering), and chemical reactions driven by these processes.

However, the space weathering mechanism of fine-grained astromaterials such as samples from the comet Wild-2 (Stardust-mission), the asteroid Itokawa (Hayabusa-mission), Interplanetary Dust Particles (IDPs), Calcium-Aluminium-rich Inclusions (CAIs) and micrometeorites has not been investigated in detail up to date. The better understanding of these processes can provide important insights on the formation of the solar system, protoplanetary disks, and planetary systems. For this purpose, efficient methods to study space weathering processes and their structural and chemical signatures in the selected samples are required.

Radiation effects on surface materials of the asteroid Itokawa were successfully studied by Micro-Raman spectroscopy, which revealed that ion implantation causes partial breaking of the crystalline or long-range order resulting in the production of radiation-induced defect centers in the albite (Kayama et al. 2011). They observed that the Raman spectral features assigned to Si-O stretching vibrational modes decrease with rising radiation dose and ion implantation. Therefore, Micro-Raman spectroscopy has a big potential for the determination of cosmic radiation defects in the surface materials of the asteroid Itokawa. This can help to interpret the space weathering processes and formation history of asteroidal and cometary surfaces. Moreover, the same method can be applied to other fine-grained astroma-

terials such as Stardust particles, IDPs, meteorites, and micrometeorites. Materials subjected to shockwaves display characteristic and irreversible physical and chemical changes on both macroscopic and microscopic scales, depending on the applied shock strength. Various techniques for the determination of the shock pressure or shock stage have been developed and applied for constituent minerals, in particular for feldspar (Langenhorst 2001-and references therein). However, these methods are not applicable to micrometer-sized particles composed of smaller grains. Moreover, according to Zolensky et al (2012-and references therein), shock metamorphism can reset chronologies in minerals, too. Therefore, a careful interpretation of the results obtained from the shock metamorphic studies is required to properly understand the shock wave history of our solar system.

Gucsik et al (2013) have used scanning electron microscope cathodoluminescence (SEM-CL) spectroscopy on the plagioclase-dominated RB-QD04-0022 Hayabusa sample containing a relatively high albitic content. They found that this sample was not affected by high-grade shock metamorphism. Furthermore, they also demonstrated that SEM-CL should be combined with micro -Raman spectroscopy in order to get more details on the space weathering processes, which would be applied for the sample-return planetary missions such as Osiris-Rex and Hayabusa-2 in the future.

Testing the visualization l of the Martian surface with GIS and SIMWE modelling tools

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Great amount of data is available of the Martian surface, and modern computer based visualization software help not only in the research but also in the outreach of this topic. The exact method of erosion on Mars is poorly understood, despite various models used for the terrestrial used for simulate the erosion-deposition rate successfully. One of the used model is the SIMWE (SIMulated Water Erosion) model (Mitasova et al, 2004), what estimate the erosion-deposition rate from from a single rain event.

The testing area where the Martan surface was visualized in 3D is East of Tinto Vallis (2°55' S, 111°53' E). The main valley is ~81 km long, ~ 1.85 km width and average depth is 250 m. From the West there are several heavily eroded valleys, what are connected to the main one. GRASS GIS 7.6 was used on the testing Hight Resolution Stereo Camera (HRSC) based Digital Terrain Models (DTM). Using this software based approach, the user is able to fly over the Martian surface, identify topographic and stratigraphic relations. It is also possible to analyse how the supposed ancient Martian water flowed on the surface and filled the closed basins. Using the SINWE model water depth and discharge from the elevation and the x/y derivatives from the slope map can be estimated in mm/hr in time (min). Several differentsediment values and the erosion-deposition rate could be presented with different colours.

The results from the test area clearly show the main falls and debris skirts and smaller erosion points, what are poorly visible on DTM or CTX images. Using Earth based values as a first and rough approach, the transport limited erosion-deposition ranges

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from 0.0180 kg/ms 2 to -0.0166 kg/ms 2 where the positive values show the erosion and the negative values the deposition. With the erosion-deposition simulation can also be used for targeting the surface sampling mission beside reconstruct the ancient transport system.

Keywords:
Mars, Martian surface. GIS, erosion modeling, 3D

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The GNSS stream gauge

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The Global Navigation Satellite Systems provide high precision positioning solutions, and are widely used in Earth Sciences for the study of recent crustal deformations. Atmospheric and space weather studies utilize the observed delays of the satellite signals to estimate the precipitable water vapor or the total electron content of the ionosphere. However, GNSS ranging observations are affected by the multipath error caused by the satellite signals reflected from nearby objects or even the ground in the vicinity of the GNSS antenna. Although this effect deteriorates both the positioning accuracy and the reliability of the derived environmental parameters, reflected GNSS signals are invaluable in the estimation of some other parameters, such as water level, soil moisture, snow depth or even vegetation indices.

Since GNSS receivers measure the superposition of direct and reflected satellite signals, the observed signal-to-noise ratios (SNR) can be utilized to estimate the depth of the reflected surface with respect to the antenna phase center.

Our study introduces the principle of SNR based GNSS reflectometry observations (GNSS-R) and shows the potential of reflected GNSS signals in the estimation of water level of rivers. Traditional stream gauge observations are affected by recent crustal deformations, since the water levels are measured relative to the index of the stream gauge. Contrary, GNSS-R observations combined with cm-level GNSS positioning provide absolute water level observations above the mean sea level or any other reference levels. Thus, all the GNSS stream gauges along a river refer to the same reference level all the time and the absolute readings are not affected by recent crustal deformations.

The concept of GNSS stream gauges are demonstrated using both geodetic and low-cost GNSS receivers on the river Danube at Budapest. The results are validated with traditional stream

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gauge readings as well as local surveys. Our results show that the absolute level of the water surface can be automatically measured with the accuracy of a few centimeters using the proposed technique and could be an invaluable tool in water level monitoring.

Keywords:
GNSS-R, GNSS stream gauge, water level, reflectometry

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The importance of educating students about careers in the space sector: a student perspective

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The UK space sector is rapidly expanding, seeing a 6.4% compound annual increase in employees since 1999/2000 and an average of 39 new companies entering the industry every year since 2012 [1]. Such growth rates are likely to increase as the UK works toward its goal to capture 10% of the global space market by 2030 [1]. To accommodate for this increase in employee demand and avoid the inevitable skills shortage which generally arises in specialist roles, an increased number of capable students will need to join the workforce year on year [2]. The UK Space Agency has recognised the important role of outreach throughout a student's academic career, in the pipeline of developing a skilled workforce [3]. While outreach activities, especially those aimed at younger students, should cultivate a general interest in space and the activities of the sector, in this paper we will highlight the necessity of expanding the scope of activities covered. Many of the existing outreach programmes tend to focus on technical subjects such as engineering, for example less than 20% of projects which ran as part of the Principia education campaign addressed non-STEM subjects [4]. This is unrepresentative of the sector, with approximately 50% of roles in the European Space Agency (ESA) being non-technical [5].

Furthermore, at the ages where students start to think about career options, they must be made aware of the careers and pathways available. This will guide the choices they make with respect to further and higher education, and encourage them to develop certain required skills early, potentially reducing the skills shortage as they enter the sector. We will therefore explore

* corresponding author

the importance of careers-focused outreach and consider methods for this, including initiatives such as the SpaceCareers.uk educational online resources and events. The discussions in this paper will focus on the UK, but are relevant to all nations looking to grow their space sector.

Keywords:
careers, space sector, education, students, outreach

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The importance of self-education through the method of citizen science from the basic experiments to the serious emergencies

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While the transmission of the information is getting more and more accelerated nowadays, we should thinking "out of the box" about the biggest milestones of the scientific era, to rate and explain and go more further in every aspect of the present and future of our lives, including the space research as the tomorrow's biggest challenge of the mankind.

While we getting more and more theoretical and practical experience about our environment up and below the horizon, we should spread the knowledge for everyone who feel enough motivation to help our mission to explore our planet in various ways or be adventurous to discover unknown depth of the void between the stars and planets far away.

We should start a long-term project, controlled and supported by the local schools and universities as resource centers for everyone, who wants to take part in it, to help the science in every way, as an innovative and creative citizen. To help this task we should make DIY small kits to which are contains quite cheap and easily available parts to assemble by everyone without age or exact qualification limit or global location to reproduce or observe the experiments in real time even at home. The results what we get from these actions makes the sampling spectrum more wider and diverged fort he scientists. With the help of the volunteer civilians we can organize smaller research groups to methodize these amount of data, remain in contact with the main institute's experts, manage workshops while they supervise, operate with the apportioned assembling kits. It allows to the smaller, and almost unreachable areas to join to an international project what was impossible before and make their new possibilities to catch up with the another parts of the globe.

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These movements in the future maybe let us to make a "KISS"-like cubesat constellation which can be very important and life-saving option in a global emergency situation-like the latest hurricane events, when all the communication channels were blocked or destroyed by the heavy storm -from any location from the Earth we can use it as a standby communication channel to help the work of the aid organizations and the lifeguards in the devastated zones.

Keywords:
civilian, citizen, school, global, emergency, cubesat

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School Amateur Radio Club Network: http://sarcnet.org/missions.html
COSPAS- SARSAT Satellite System for Search and Rescue: http://www.sarsat.noaa.gov/satellites1.html

The Technology Transfer Program of the European Space Agency from thePerspective of Budapest University of Technology

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The European Space Agency is managing the development of Europe's space capability and ensures that investment in space continues to deliver benefits to the citizens of Europe. The Agency's projects are designed to study the Earth, its immediate space environment, the solar system and the Universe, as well as to develop satellite-based technologies and services. New technologies, systems and processes are continuously being developed for space programs and many of these have non-space applications.

ESA's Technology Transfer Program Offices are established initiatives for space technologies to be identified and adapted for non-space use that result in commercially viable products and high potential companies.

Within the framework of the "Technology Transfer Demonstrator Competition 2017-2019", the department of Broadband Infocommunications and Electromagnetic Theory (BME-HVT) at Budapest University of Technology and Economics successfully finished a technology transfer demonstrator project.

The demonstrator project is based on the former and actual research activity of BME-HVT in ESA's Alphasat Ka/Q-band propagation and Q-band telecommunication program. In the Alphasat related research work our department developed a Q-band satellite communications system, and the millimeter wave downconverter unit has been applied and successfully transferred to a terrestrial radio wave propagation measurement system that is suitable to study the terrestrial millimeter wave signal propagation for the future 5G mobile radio systems. During the

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execution of the project we performed indoor radio wave propagation sounding measurements in the 38GHz band and we tested different indoor scenarios. The results are compared with the relevant ITU-R recommendations and models.

This paper outlines the ESA Technology Transfer Program, introduces the measurement system that was developed at BME-HVT for this project and some results and conclusions will be also presented. It will be also shown how the results of this project are applied in our current research and education programs at the university.

Keywords:
indoor propagation, millimeter wave, 5G

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The work of Cosmos Society on introducing the importance of space to thegeneral public

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In the summer of 2019, Cosmos society aimed to introduce space to a wide range of young Hungarians. Our goal was to relate with every field of science, focusing on non-STEM. With presentations, experimental demonstrations and panel discussions, we managed to find a common ground form which, more advanced talks about space-related activities were held.

Following our work about Overton-windows last year, we were discussing and using concrete techniques to introduce the topic to people aged between 20-30 and help them better understand the importance of supporting space activities.

In accordance with the European Space Agency's Education activities [1], we used space as context instead of using it as the subject. This means that just like in primary schools, the projects are made more interesting for pupils, we also tried to get law and social sciences students' interest by approaching space from their point of view. On our most successful panel discussion at the Hungarian Bánkitó festival, participants came up fascinating ideas about the martian society of the future. Although this seems as an image form the distant future, we managed to talk about more recent topics, such as moon exploitation, space debris, or space tourism.

We must accept, our efforts to popularize space will not always be successful, as we experienced at EFOTT festival, however, learning from these failures, and understanding the problems of our communication is indispensable for success.

We hope that sharing our experience, gathered at fresher man's camps of the Budapest University of Technology, Bánkitó and EFOTT festivals, and People Team youth camp, will help the Hungarian space community in communicating their work.

Media is not always in favour of raising funding on space activities, memes will be made to make fun of our efforts, but at Cosmos Society we believe, that this attitude can be changed by direct and well-planned communication with the people.

Keywords:
public outreach, popularization, youth

Reference:
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Thermal Thorium Rocket (THOR) – a new concept for a radioactive decay heated thermal rocket engine

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Until now, radioactive heat powered thermal rockets have not attracted much interest. The isotopes used in radioactive heat sources either volatilize at the normal working temperatures of rocket engines, or have very low power densities, and thus the concept was condemned as useless several decades ago. Due to their strong gamma radiation, the so called cascade decaying isotopes have not been previously considered, although technological advances have made their use possible. In particular, the Th-228 isotope seems to be best suited for powering a rocket due to its high thermal output and the very high melting point of its oxide. Although such a radioisotope powered thermal rocket has a low thrust, in theory it can operate continuously for several years, allowing it to move large masses in the Solar System. The concept is viable at the level of currently available technology.

Visualization and simulation of ion thrusters possibly usable by small satellites

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After launching a small satellite and placing it into its final orbit, it can have unwanted and uncontrolled rotation. Therefore a small satellite needs to perform some maneuvers to stabilize or slightly change its position on its orbit. Due to its small size it needs only a small drive system and torque to stabilize. Furthermore, the available energy for attitude control is also limited.
Ion thrusters use ionized neutral gases accelerated by electric field to drive the spacecraft or change its attitude. As ionized gas flies out of the thruster it makes an opposite directed force. If we use different outlets for ions to fly out from thruster it can act like a three dimensional steering system.
A process of finite element based solution is used to calculate quasi-electrostatic field of the internal the thruster. It is also used to perform simulations on the outlets. Using the field calculated we can show possible allowed and forbidden paths of ions spreading inside and outside of the outlets.
We present a visualization technique to show the internal world of a possible three directional steering system. Visualization of our results is import to understand operation of device and find possible improvements. Also it can be used to illustrate internal operations of the thruster for educational purposes.

Keywords: visualization, ion thruster, small satellite, steering

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We touched space twice in 2019

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Our philosophy is that students need to be guided to the world of STEM latest in High School. We consider Space as one of the most interesting topics for children, that catches the most attention. For this reason, we have been participating in ESA's Astro Pi Mission since the first one launched in 2016.

Now our team is in the international finals, for the fourth consecutive time. We already have two successful experiments, that ran on the ISS and collected scientific data and pictures of the Earth's Surface.

This year our Astro Pi Experiment's main objectives were Investigating Light Pollution, measuring the density and proving the globular shape of planet Earth. Unfortunately, we don't have stunning pictures of the light pollution of cities, due to them appearing small in the camera. We do have interesting images though, of for example the Canary Islands, the Great Lakes, the Sierra Nevada range and much more.

Projects like the Astro Pi Mission are great to teach students the importance of coding, and teamwork in scientific experiments. It lets them ask their own questions about how the world works and instead of answering them, it lets them figure it out by themselves. It is a good opportunity to learn about how space experiments work on the ISS, it doesn't however include the aspects of planning hardware for an experiment or planning it's launch and data recovery.

After our successful Astro Pi 2019 mission, we teamed up with the Vega Astronomical Association, to conduct our own weather balloon-based space experiment, without the help of equipment already launched to space. The goal was to image the Earth's curvature and collect measurements of Its magnetic field from

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Near-Space. The launch was completely crowdfunded by members and supporters of the association. The “scientific payload” of the balloon included a fully functional Astro Pi machine, a GPS Tracker and an Action camera. The balloon experiment was very successful, reaching more than thirty kilometers in altitude, even though it took 5 weeks to find our probe from the launch at this year’s VEGA Astronomy Camp, due to a faulty tracker unit.

Both our Astro Pi Mission and our High-Altitude balloon brought back some interesting data and images. This includes possibly the first image of Jupiter imaged from a weather balloon, and one of the first images of light pollution from an Astro Pi.

Keywords:
Astro Pi, education, High-Altitude Balloons, research-based teaching, space generation

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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.

The 6th International Conference on Research, Technology and Education of Space was held on February 26-27, 2020.

H-SPACE 2022, the 7th International Conference on Research, Technology and Education of Space is planned to be organized in February 2022 in Budapest, Hungary.

The Call for Papers will be available from September 1, 2021 on the http://space.bme.hu website.

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