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PROJECT ACRONYM: **SPACE EDU**

SUMMER SCHOOL ON SPACE AND TECHNOLOGY FOR ALL

MINUTES

The "Summer School on Space and Technology for All," held on 3th July-6th July, 2023 in Thessaloniki, Greece, was a celebration of knowledge, curiosity, and a shared passion for space and technology. The event brought together an eclectic mix of trainers and trainees, each presentation serving as a stepping stone into the realm of space exploration and technological innovation. Here, we present a concise summary of each presentation:

Day 1 – 3 July

1. Opening Speech: "EU role in Space and Space Education"
   Ms. Paraskevi Papantoniou – Deputy Director for Space and the Head of the Space Policy Unit in the European Commission - Directorate-General for Defence Industry and Space (DEFIS)
   Summary: *"Europe has historically been at the forefront of space exploration, investing massively in space infrastructures such as in the Copernicus and Galileo programmes. It still boasts academic and scientific excellence but it is at risk of losing out on the next wave of space innovation unless it seizes the opportunity to stimulate more investment in the new space sector. Until recently, space used to be synonymous with government spending. However major technology advancements and a new entrepreneurial spirit are rapidly shaping a new space economy at the EU. EU Space ecosystem needs access to science and to key technologies to innovate, develop and manufacture and to guarantee competitiveness and resilience. It is essential to preserve a European edge on space education on critical and emerging technologies, in strategic and critical sectors as space. In addition, we need to tackle educational gap, especially between men and women, and to step up on space education, by investing in space educational programmes and partnering with Higher Education Institutions across Europe."*

2. "Bubbles and Waves: Intersecting Pathways in Space Culinary and Earth's Water Quality Reservoir Surveillance"
   Dr. John Lioumpas - R&D EYATH
   Summary: *"The presentation demonstrates the value of space-based technologies in studying frying in microgravity and monitoring water quality with satellites. These scientific endeavours offer practical benefits both for life on Earth and future extraterrestrial exploration."*

3. "Space applications: An overview"
   Ms. Dimitra Stefoudi – PhDc at Space Law, University of Leiden
   Summary: *"Space applications refers to the application of scientific knowledge and engineering principles to explore and utilize outer space to daily life. It encompasses a wide range of technologies and systems that enable space data, human activities in space and earth, such as weather forecasting, navigation, satellite communications, Earth Observation. Space downstream applications has significantly advanced over the years, and it continues to play a crucial role in various aspects of modern daily life. Space exploration and development have been stimulated by a complex mixture of motivations, including scientific inquiry, intense competition between national governments and commercial profit. The various applications of space capability hold the greatest promise for significant change. The Outer Space Treaty identifies space as "the common heritage of mankind." How to ensure that the benefits of this common heritage are more equitably distributed will be a continuing challenge."*

4. "Space threats and International Politics"
   Mr. Ilias Tsitsios – MSc, LLM, NATO Air Operations Coordination
   Summary: *"The lecture aimed for defining modern space threats both theoretically and practically. With respect to the latter, space actions were evaluated under specific factors that facilitate, either alone or in combination, their characterization as threats to space infrastructure. After an analysis of the existing counterspace weapons, space actions were presented in a legal spectrum ranging from friendly actions to an armed attack condition. Examples of recent States' space activities within the international arena were also provided in order to facilitate understanding. Finally, emphasis was given in presenting the different interpretations States give, with respect to specific actions, as well as how the same actions were perceived by the rest international community."*

<u>Day 2 – 4 July</u>

1. "Basics of orbital mechanics"
   Prof. Valentin Rakovic – Faculty of Electrical Engineering and Information Technologies, Ss. Cyril and Methodius University in Skopje
   Summary*: "The lecture focused on elaborating the basic concepts related to orbital mechanics. Specifically, it provided the fundamentals on Keplerian orbital motion and how the model can be applied to artificial Earth-orbiting satellites. Also, the lecture, discussed the different types of orbits used for satellite deployment, and how they serve different purposes with respect to different applications, such as navigation, telecommunications, remote sensing, etc."*

2. "Introduction to satellite and deep-space communications"
   Prof. Zoran Hadzi-Velkov – Ss. Cyril and Methodius University in Skopje
   Summary: *"The lecture/course explained the need for artificial satellites, emphasizing their importance, diverse applications and distinct advantages over terrestrial systems. Different types of satellite orbits, including low Earth orbit (LEO), medium Earth orbit*

(MEO), and geostationary orbit (GEO), were presented along with different satellite topologies and applications. As a primary application of satellites, the course presented the basic elements of satellite communication systems and the fundamental properties of wireless signal propagation in the various radio frequency bands used for satellite communications. The course also explained the concept of deep space communications, which involves interplanetary probes and rovers for lunar exploration, planetary exploration, interplanetary and astronomical exploration."

3. "Activities and on-going project"
   Aristotle Space & Aeronautics Team – ASAT
   Summary: "*This presentation will focus on providing an overview of the Aristotle Space and Aeronautics Team (ASAT). Firstly, ASAT, established in 2015, stands as the largest aerospace student team in Greece, boasting over fifty dedicated members. It operates under the auspices of the Laboratory of Fluid Mechanics and Turbomachinery at the Aristotle University of Thessaloniki. Subsequently, we will delve into the four integral departments within ASAT: aeronautics, rocketry, marketing, and resources, and highlight their respective accomplishments. Lastly, we will explore ASAT's vision, primary objectives, and noteworthy technological advancements.*"

<u>Day 3 – 5 July</u>

1. "The role of Satellite Communications in Beyond 5G Networks"
   Prof. George Karagiannidis – School of Electrical and Computer Engineering, Aristotle University of Thessaloniki
   Summary: "*A lecture on the role of satellites in beyond 5G networks was delivered. Firstly, the evolution of networks from 1G to 5G, which has transpired over the past thirty years, was discussed. Next, the fundamentals of networking, including non-terrestrial, satellite, and hybrid networks in the context of beyond 5G, were presented. Finally, the presentation was concluded by addressing the primary challenges that networks will encounter in the next decade. These challenges include the reduction in the cost and size of satellites, improvements in communication service quality, and the need for stable access to satellite spectrum to fulfill their role in 5G, among others.*"

2. "Space Exploration & European Space Agency"
   Prof. Thodoris Karapantsios – School of Chemistry, Aristotle University of Thessaloniki
   Summary: *"Sky is a source of imagination, inspiration for logical thinking and sciences and motivation to go beyond the limits including new destinations, new knowledge and new opportunities. European Space Agency (ESA) has been established in 1975 with the aim to promote science, research and space applications, for peaceful uses. ESA has 22 member states, 4 linked member states and 5 co-operating states that participate in certain projects through memorandums of cooperation. The member states participate in space science related activities in the framework of mandatory projects as well as optional projects concerning: earth observation, telecommunications, navigation, launcher development, manned space flight, microgravity research and exploration. Representative outcomes of projects focused mostly on the last three topics are shortly presented to give an idea about the content of space research and its connection with applications on ground."*

3. “Life Support Technologies in Space: A Chemical Engineering Approach; Systems for environmental control in confined environments”
   Prof. Sergio Caserta – Università degli Studi di Napoli Federico II
   Summary: “One of the main obstacle to human missions to Mars is not the lack of powerful spacecraft but rather the need to ensure safe living conditions due to the planet's great distance from Earth. Closed and confined spaces like the International Space Station (ISS) require efficient Environmental Control and Life Support Systems (ECLSS) to manage temperature, humidity, and air quality. Furthermore, ECLSS also encompasses critical components like Water Recovery, Recycling, and Resource Utilization, Food Production, Nutritional Requirements, and Waste Management, in order to create a closed-loop systems. As regards the food production, bioengineering approaches are being explored to cultivate plants and produce fresh food in microgravity environments. Considering these aspects, the European Space Agency's (ESA) launched a new project called Micro-Ecological Life Support System Alternative (MELiSSA) which aims for self-sustaining life support on long-duration missions, producing essentials like food, water, and oxygen from mission waste. As space exploration ambitions grow, advanced life support systems are essential. For this reason, NASA and ESA stress the significance of research and technology to overcome long-duration mission challenges.”

4. “Life Support Technologies in Space: A Chemical Engineering approach; Biomedical Engineering”
   Prof. Stefano Guido – Università degli Studi di Napoli Federico II
   Summary: “*NASA's Human Research Program (HRP) is a comprehensive initiative focused on addressing the health risks of extended space missions, particularly for Exploration Class missions. These missions involve deep space travel, which poses significant biomedical concerns. HRP conducts extensive research to identify and understand the health risks that astronauts may encounter during spaceflight such as bone density loss, muscle atrophy, cardiovascular problems etc. due to several factors (microgravity, confinement, and exposure to space radiation). Spaceflight-related cardiovascular diseases have gained attention, particularly after the discovery of venous thrombosis in an astronaut on the International Space Station. Researchers employ innovative technologies, including Lab-on-chip devices, which are capable to integrate multiple functions that can be performed in the laboratory in a single. Furthermore, a promising approach capable of emulating the structure and function of specific human organs or tissues, is founded on organ-on-chip. Future perspectives in this field of research regards the device integration and scale-up production in a sustainable way but more research and innovation with a cross-disciplinary breadth is needed to overcome the current limits and exploit the full potential of the technology.*”

5. “Mars Exploration and the Quest for the First Return of Samples to Earth”
   Dr. Yiangos Mikelides – NASA Jet Propulsion Laboratory
   Summary: “*The presentation centered on the captivating theme of Mars Exploration and the Quest for the First Return of Samples to Earth, illuminating key topics. It commenced with an exploration of why the Mars Exploration Program views Mars as an integral component of the planetary system. Following this, the audience was taken*

on an informative journey through Mars exploration, particularly focusing on NASA-led Landers. Striking visual aids showcased Mars landing sites, underscoring the 2020 mission's multifaceted objectives, encompassing geologic exploration, habitability studies, and the search for biosignatures. The intricacies of the Mars 2020 Spacecraft and an update on the current Mars 2020 Mission Status were expertly detailed. Additionally, the presentation addressed NASA's robust Planetary Protection policies and requirements. The meticulous reliance on physics-based analyses and testing to meet stringent planetary protection prerequisites for Mars 2020 was underscored. The Mars Sample Return (MSR) initiative took center stage, with a comprehensive exploration of its planetary protection categorization."

6. "Artemis Accords: The beginning of the future"
   Summary: "Dr. Rebecca Bresnik – NASA Office of the General Counsel
   The lecture included an overview of the Artemis Accords, a framework for cooperation among nations participating in lunar exploration and space activities. The Artemis Accords outline principles such as peaceful exploration, transparency, interoperability, and the preservation of space heritage, ensuring that all nations can work together in a safe and sustainable manner. The commitment to preservation of space heritage reflects the shared responsibility of all nations to safeguard humanities collective heritage in space. The accords also emphasize the importance of interoperability we're participating nations will strive to use compatible systems and standards to facilitate cooperation and resource sharing on the moon. As of June 2023, there are 27 signatories to the Artemis Accords."

Day 4 – 6 July

1. "Biofilm, when bacteria get organized!"
   Dr. Romain Briandet – Micalis Institute, Université Paris-Saclay, AgroParis Tech
   Summary: Over the last decades, the perception of microbes has shifted from unicellular to biofilm communities. These dynamic habitats adapt to environmental changes, ensuring microorganisms' survival. The biofilm's functional properties are influenced by its three-dimensional structure, regulated by self-produced components and interconnected mechanisms. Processes like matrix production, spatial reorganization of interactions, physiological heterogeneity, motility regulation, and enzyme production contribute to spatial organization plasticity. Harnessing these characteristics offers a way to control biofilm functionality, beneficial or deleterious.

2. "Microbial responses to microgravity-induced biofilm formation"
   Dr. Marie-Françoise Noirot-Gros – Micalis Institute, Université Paris-Saclay, AgroParis Tech
   Summary: *"This course aimed to provide an overview of current knowledge on how bacteria respond to microgravity. The propensity of bacteria to form biofilms is a concern for crew health as well as potential bio-corrosion activity on many surfaces inside the space habitat. Understanding the behavior of microbes in space is an important issue for the safety of long-duration missions. The course provided an up-to-date overview of the ISS microbial content and describes the phenotypic and genetic responses of bacteria in the absence of gravity. Overall, this presentation*

summarized what is known about the role of microgravity in the emergence of the particular properties of bacterial biofilms in space, and how bacteria adapt their response at the genetic to molecular level."

3. "Passive limitation of surface contamination by perFluoroDecylTrichloroSilane coatings in the ISS during the MATISS experiments"
   Dr. Laurence Lemelle – CNRS, Laboratoire de Géologie de Lyon-Terre Planètes et Environnement, ENS Lyon
   Summary: "Biocontamination in manned spacecrafts and future habitats could have significant impacts on crew health and biodegradation of equipment. In particular, there is a need for decreasing the dependency of crew action for cleaning actions. Anti-microbial surfaces that inhibit or reduce the ability of microorganisms to grow on the surfaces are of high interest in the context of future manned mission scenarios of longer duration and higher isolation."