Space Sciences and Technologies

Report of Abstracts

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Abstract ID : **1**

COPUOS for a reordering world

Content

In this paper I will present a role for UN COPUOS in a world that differs radically from the institution as conceived at the dawn of the space age. I will also address ways how Europe, and a small member-state like Latvia can more effectively use of COPUOS to advance Europe-wide interests in outer space.

The world is facing multiple crises whose management or resolution requires significant cooperation among nations in the peaceful uses of outer space. The UN Committee for the Peaceful Use of Outer (COPUOS) is the central global institution to advance international cooperation in outer space. COPUOS was formed in 1957 shortly after the launch of Sputnik, which took place during the International Geophysical Year (IGY 1957-8). Then there were only two spacefaring powers – the U.S. and the USSR. The initial task was to set the foundations for international law to govern outer space affairs which rapidly expanded to include satellite telecommunications and earth observation. The overriding mission of COPUOS was to prevent the militarization of outer space. Now most states use satellite services, launch costs are dropping dramatically and the number of states and private companies launching satellites is growing rapidly. China now overshadows Russia in outer space, Europe with ESA and several national space agencies has emerged as a major space power. India has demonstrated the capacity to reach Mars as have several other states. Africa is an awakening space power with multiple countries launching satellites and possessing capacity for equatorial launch not possessed by any other region.

The increasing importance of use of outer space to human activities on Earth, including for military conflict, is resulting in a widening array of military space weapons and military units operating the space environment such as the U.S. Space Force [1] to protect critical space infrastructure. The ambitions of major space powers reach far into the Solar System with significant differences in space policy between the U.S. and its partners and China with its partners including Russia. COPUOS is the forum intended to resolve differences and to foster a rules-based order for outer space activities. China uses COPUOS to advance its space agenda and interests very actively as compared to the U.S. and Europe. This suggests the need for Europe to develop a European approach [2] to more actively advance Europe-wide interests in outer space through the COPUOS forum.

Importance of the Moon Treaty

The Moon Treaty was negotiated for nearly a decade until unanimous agreement was reached at the June 1979 meeting of COPUOS. U.S. leadership helped achieve consensus on the question of the concept of Heritage of Mankind" as applied to cosmic bodies and outer space resources. This remarkable achievement in Vienna was met with acrimony in Washington as mining interests sought to undermine the Moon Treaty and prevented its ratification. Without the U.S. as a party to the Moon Treaty few states chose to become parties and the Treaty with 18 states parties was viewed as a dormant agreement. Now that the U.S., China, ESA and other space powers are developing technologies to use space lunar and asteroid resources and there is no international agreement other than the Moon Treaty governing the use of space resources the Moon Treaty can emerge as the key to the establishment of a rules-based-order for the industrial development of outer space. Without agreed to rules the risks of conflict will increase and could prevent development. [3]

COPUOS background

to address governance of the peaceful uses of outer space and formally endorsed by the U.N. General Assembly In 1959. It is headquartered in Vienna with secretariat services provided by UNOOSA, United Nations Office for Outer Space Affairs. UNOOSA manages several other space agencies including UN SPIDER, which provides information management services for disaster relief for developing countries.

COPUOS and its 99 member states discuss issues including the regulation of space debris, the extraction of space resources, the standardization of small satellites such as CubeSats, the nucleariza-

tion of outer space, and threats posed by asteroids and other types of space rock, among other areas requiring purposeful space law. The work of COPUOS is divided between two subcommittees—the Scientific and Technical Subcommittee that meets in February, and the Legal Subcommittee that meets in March with an annual meeting in June to discuss issues relating to the major space treaties and international mechanisms for cooperation in space.
COPUOS Negotiated the five major space treaties from 1966-1979 and administers their implementation:
 “Outer Space Treaty” - The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies
 “Rescue Agreement” - The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space
 “Liability Convention” - The Convention on International Liability for Damage Caused by Space Objects
 “Registration Convention” - The Convention on Registration of Objects Launched into Outer Space
 “Moon Treaty” - The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies
REFERENCES
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[2] V. Beldavs, “Europe needs a flagship for outer space”, https://www.euractiv.com/section/climate-environment/opinion/europe-needs-a-flagship-for-outer-space/
[3] “Response to Louis Friedman a second race to the moon is a second-rate goal” V. Beldavs, J. Crisafulli, B. Foing, J. H. Rogers, https://www.researchgate.net/publication/339540216_Response_to_Louis_Friedman_a_second-rate_goal-2020-02-25

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Abstract ID : 2

Electrify Africa 2030: The role of space technologies

Content

The Electrify Africa 2030 consortium is being created to address the important and urgent problem of over 600 million people in Africa with no connection to reliable electrical power. This slows sustainable development and impedes adaptation to climate change in a vast continent of abundant natural resources and human potential stymied by the failure of traditional approaches to electrify the continent. Solutions are emerging to deliver broadband internet communications to people across Africa creating opportunities for information and communications, telehealth, government services and more. Cell phone technology has opened a wide range of services including financial services for trade but cell phones must be charged and the cell-phone transmission towers and routers must be connected to a source of electrical power. Food security is emerging as a primary concern with reliable electricity offering the capacity for advancing agricultural practices, water pumping for irrigation, refrigeration of crops, cooking, transportation, and many other services.
Current trends indicate that the number of people in Africa with no connection to reliable electrical power could increase by 2030 despite construction of significant large-scale power generating and distribution capacity. If extreme weather events continue to disrupt electrical power distribution as in recent years integrated large-scale grids with points of failure that can disrupt service across large territories may need to be strengthened with microgrids with independent power generating capacity. This could mean that micro-grids could serve as elements of large grids enabled by smart grid technology assuring reliable distribution of power both in areas of highly develop electrical infrastructure as well as areas such as much of Africa where such infrastructure is absent.
Electrify Africa 2030 became a focal theme of the \[11TH ANSOLE conference\]held on 4 February 2020. ANSOLE is the African Network for Solar Energy of which the Riga Photonics Centre is an institutional member.
References

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Stars and their Spectra. From historical beginnings to challenges of tomorrow

Content

Detailed spectroscopy of astronomical objects started with Joseph von Fraunhofer's studies of solar spectral lines around 1810, although he did not yet interpret them in terms of physical conditions on the Sun. Some decades later, Gustav Kirchhoff and Robert Bunsen showed how different chemical elements cause emission and absorption lines. In the same epoch, new observatories were erected worldwide, and astronomers started to look at stellar spectra. The relation between precise spectral-line wavelengths and radial motion of the source became understood, and in the late 19th century, first measurements of such a Doppler effect in different stars were realized. From the laws of planetary motion, it followed that sufficiently precise measurements would reveal the presence of smaller bodies in orbits around stars. Following decades of developments, discovery of the first exoplanets was achieved toward the end of the 20th century. However, a major challenge still remains in finding planets similar to the Earth. The limitations no longer are the imprecision of instruments but rather the intrinsic variability of stellar surfaces which causes a jittering of spectral-line wavelengths much greater than the tiny signal expected from small Earth-like planets.

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Multi-spacecraft space plasma missions

Content

Multi-spacecraft missions Cluster (ESA 2000-), THEMIS (NASA 2007-), and MMS (NASA 2015-) are intensively used by space scientists to understand the physics of space plasma processes in the near Earth space. These missions have allowed to address the physics of shocks, reconnection, turbulence, substorms and many other topics of importance in both the near Earth space and astrophysical plasma environments. To achieve further progress in the field it is important that next generation multi-spacecraft missions addressing several physical scales at the same time are implemented. One such mission is Helioswarm, it has been recently selected by NASA to study solar wind turbulence. In addition, other concepts of such missions, such as Plasma Observatory, MagCon, NEO-SCOPE, AME are being developed in different countries worldwide. Similar development towards multi-point multi-scale measurements is ongoing in the studies of the ionosphere using sounding rockets.

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Abstract ID : 5

Processing service «Lemur» of optical frames for the formation of high-precision observations of asteroids, satellites and variable stars

Content

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LEMUR is one of the best software for automatic multithreaded data processing of astrometric and photometric optical observations. Implemented as a service and independent standalone/local/built-in/corporate software. High level of data processing automation due to the many years of formalized experience of astronomy professionals and amateurs, customers and developers. Relieves the observer's stress by removing the operations such as manual frames comparing for objects detection, choosing photometric standards, and much more.
LEMUR can organize automatic detection of moving objects and light curves on frames from many telescopes of the observatory. Help create a moving object detection service for processing frames of amateur astronomers. Automate your observational astronomy tasks.
LEMUR intraframe processing has five modules: brightness equalization and cosmetics, frames segmentation, estimation of parameters of objects images, matched filtration of images, frames identification and astroreduction.
LEMUR interframe processing has four modules: detection of fast, slow and non-zero motion, detecting satellites GEO, MEO and LEO fast, accurate and mass photometry.
The module of "Brightness equalization and cosmetics": compensates uneven sensitivity and defects of the CCD-camera, eliminates spurious illumination from extraneous light sources (lights, passing cars), as well as uneven illumination of the frame at "dawn" or near bright stars, which allows dispensing with flat frames, the use of aligned in brightness frames significantly reduces the errors in detection and parameters estimation of objects images.
The module of "Frames segmentation": determines the set of CCD-camera pixels that correspond to the images of the objects in the frame, uses a complex of classical and original segmentation methods with their adaptive automatic selection for each frame and segment in it, classifies objects images into "circular/extended", and also selects "anomalous pixels", forms segments for objects with small size and for images of large stars with diffraction stretches, forms segments for super-extended objects.
The module of "Parameters estimation of objects images": determines the exact rectangular coordinates of objects, instrumental brightness, signal-to-noise ratio, length and other image parameters, analytical parameters estimation of circular and extended images of objects before and after the matched filter, parameters estimation of the images of the objects with an analytically undefined profile before and after the matched filter, instrumental brightness estimation of circular and extended images, as well as images of objects with an analytically undefined profile.

The module of "Matched filtration of images": selects images of faint stars and objects, reduces the number of false objects, matched filtration is implemented for images of objects: circular (frames with daily tracking), extended and with an analytically undefined profile (frames without daily tracking).
The module "Frames identification, astrometry, photometry": find the correspondence between stars images in frame and data of modern star catalogs, forms a catalog of objects motionless in a series of frames, establishes an analytical relationship between the rectangular frame coordinate system and the international reference coordinate system ICRS, photometry: establishes an analytical connection between instrumental brightness and brightness in the selected star catalog, linear, cubic and fifth-degree astrometric reduction models are available, automatic selection of astrometric reduction model is implemented, robust automatic selection of reference stars is implemented.
The module of "Detection of moving objects with near-zero apparent motion": Detects objects with almost imperceptible visible movement (commensurate with errors in position estimation of objects), including objects approaching the Earth at large distances.
The module of "Detection of fast moving objects": detects objects with images blurred by their own motion, discovers NEO when they are approaching the Earth, detects satellites in daily tracking mode.
The module of "Detection of moving objects in normal speed range": detects and discovers comets, asteroids and satellites in automated mode, uses the method of light-collecting, which allows energy accumulation of the images of the objects along trajectories with unknown parameters, which provides high-quality detection in telescopes with a small aperture, works at low thresholds and allows to see very faint and hardly observable objects, for observation of which by traditional methods it is necessary to increase the observing potential in several times, the software has linear complexity with the number of the measurements per frame, which allows working at low thresholds and detecting a motion against the background of 5000 false measurements and 20,000 stars.
The module of "Accurate photometry": allows the accurate light curves creation of variable stars even by astronomy amateurs due to the formalized and software-implemented experience of observers, scientists, software developers, allows forming a list of comparison stars only once for their subsequent usage in all observations, do mass photometry is implemented with automatic light curves creation for all stars in frame with specified properties and accompanying comparison stars selection.
The Module of "Visual control of results": visualization of a series of frames and detected satellites, comets, asteroids, automated satellite measuring in a series of frames: it suffices to mark the satellite in two frames, after which its measurements will be done automatically in the remaining frames with ability to control, analysis of satellite measurements in a series of frames: visualization of deviations and measurements censoring, reports generation with measurements of asteroids and satellites in the international formats, initial determination and clarification of satellite orbit elements, on-line loading and identification of detected asteroids and comets from MPC data allows to quickly make a decision about the possible presence of new asteroids and comets in series of frames.
The immediate goals: rework the modules of the client part (project manager, config editor) - this will make the work with the data that need to be processed more comfortable, implement the TLE service - it will allow the observer to see the data from the NORAD catalog on the processed frames, to implement the addition of the frames in the given range of speeds in order to automatically find the super-weak objects of the solar system.
Test results at the Baldone Astrophysical Observatory on the more than 900 CCD images processing bases: Lemur performance the series of 50 CCD images (1638.75MB) full process at 22 minutes, the differences of individual position measurements do not exceed 0.2 arcsec compared to the "Astrometric" software position measurements, the average error in measuring the brightness in Gaia

G(R) passband is 0.05 mag.

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Research and Training by Space and for Space: EuroMoonMars Earth Space Innovation

Content

We discuss results and opportunities (with Fotonika LV and partners) of Research and Training for Space and by Space: EuroMoonMars Earth Space Innovation. We build on EuroMoonMars, an ILEWG programme in collaboration with space agencies, academia, universities and research institutions and industries. The programme includes research activities for data analysis, instruments tests and development, field tests in MoonMars analogue, pilot projects , training and hands-on work shops , and outreach activities. Extreme environments on Earth often provide similar terrain conditions to sites on the Moon and Mars. In order to maximize scientific return it becomes more important to rehearse mission operations in the field and through simulations. EuroMoonMars field campaigns have then been organised in specific locations of technical, scientific and exploration interest. Field tests have been conducted in ESTEC, EAC, at Utah MDRS station , Eifel, Rio Tinto, Iceland, La Reunion, LunAres & AATC bases in Poland, and at Hawaii and Atacama .

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