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Space debris

Research on space debris, safety of space objects with nuclear power sources on board and problems relating to their collision with space debris

Note by the Secretariat

Addendum

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* A/AC.105/C.1/L.392.

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Bolivia (Plurinational State of)

[Original: Spanish]
[19 October 2021]

According to the functions of the Bolivian Space Agency (ABE) as set out in Supreme Decree No. 423 of 10 February 2010, the role of the Agency concerns the provision of services relating to satellite communications and the analysis of satellite images. Consequently, ABE is not conducting research on the topics referred to by the Office for Outer Space Affairs.

Cuba

[Original: Spanish]
[2 November 2021]

Space debris mitigation and the number of space objects in the geostationary orbit are key elements in achieving the sustainability of outer space activities.

Improvement of the safety of space operations and the protection of the space environment is to be conducted, giving consideration to acceptable and reasonable financial and other connotations and taking into account the needs and interests of developing countries.

It is recommended that States and international organizations continue their research on the sustainable use of outer space and the development of sustainable space technologies, processes and services in order to increase the body of knowledge that exists for conducting space activities in a safe and sustainable manner. As the conduct of space activities evolves, and as more knowledge is gained, the guidelines should be reviewed and revised periodically to ensure that they continue to provide effective guidance to States and to all space actors to promote the long-term sustainability of outer space activities.

As part of a cooperation agreement with Russia, a telescope will be installed at the Institute of Geophysics and Astronomy to track near-Earth objects, which will make it possible to monitor not only asteroids and other space bodies but also space debris.

Use of nuclear power sources in outer space (work for 2020 as reflected in the multi-year workplan of the Working Group on the Use of Nuclear Power Sources in Outer Space (A/AC.105/1138, annex II, para. 9))

It is necessary to achieve a balance, in the text of any documents adopted, with respect to limiting and controlling the use of nuclear power sources, without being so categorical as to prohibit such sources altogether, provided that the safety standards established in the approved Safety Framework are complied with.

Portugal

[Original: English]
[9 November 2021]

With space becoming a more and more important asset in many sectors, it is crucial to take care of space infrastructures in order not to compromise the operation of satellites and the services depending on them. Space debris is one of the biggest and most serious challenges faced by space exploration and space activities. As the sustainability of space operations is one of the country’s priorities, Portugal is concentrating efforts on this problem.

Through the participation of Portugal in the European Space Agency (ESA), Portuguese industry and research centres are actively involved in several space debris mitigation-related activities. The Active Debris Removal/In-orbit Servicing programme, to be carried out through the ClearSpace-1 mission, will be a proof-of-concept mission intended to de-orbit/remove an ESA debris object and recognizes the leadership of Portuguese companies in major systems.

To mitigate the creation of new debris, it is important in the early phases of spacecraft design to take into account the end of life of satellites and to ensure the removal of the objects from their orbits once they have fulfilled their purpose or in the case of a malfunction. Under ESA, a debris removal demonstration activity focusing on the development of a de-orbit kit involves Portuguese expertise in both software and hardware. De-orbit kits can be used to de-orbit satellites at the end of their lives by making it possible to perform a controlled re-entry.

When collisions or other fragmentation events occur, more debris is created and the problem is aggravated. To ensure the continuity of space operations and access to space, space debris mitigation is imperative. The Collision Risk Estimation and Automated Mitigation programme of ESA is focused on the development of techniques for automated avoidance manoeuvre decisions, with Portugal developing state-of-the-art machine learning and deep learning techniques to enable automated avoidance manoeuvre decisions.

Nonetheless, in order to take advantage of advanced tools such as artificial intelligence and machine learning while improving collision risk estimation and automated manoeuvre decisions, such as course corrections, and to mitigate the risks associated with space debris, it is necessary to have sufficient and reliable data by surveying and tracking such objects and providing that information to a variety of stakeholders. To ensure Europe’s access to those data, and with the support of the European Union, the European Union Space Surveillance and Tracking (EU SST) consortium has been gradually building tracking capabilities. The consortium is currently composed of seven countries, and Portugal, through the Ministry of Defence, has cooperated in the enhancement of these capabilities by integrating Portuguese sensors into the EU SST network.

Furthermore, one of the main objectives of Portugal Space is focused on investment in space research and technology development, which is also promoted by the Portugal Space PhD scholarships programme, carried out through a partnership with the Portuguese Science and Technology Foundation. The PhD programme covers diverse areas of the space landscape, and one of the calls is exclusively dedicated to research and development of space safety technology.

Saudi Arabia

[Original: Arabic]
[31 October 2021]

The Kingdom of Saudi Arabia is interested in space as a promising sector for catalysing domestic industries and diversifying domestic sources of income, which are an essential component of its Vision 2030. The Saudi public and private sectors have many assets in space. The Kingdom is therefore focused on raising awareness of space risks to ensure the safety of the space environment.

The Kingdom, represented by the Saudi Space Authority, has adopted many measures concerning space debris and activities that can increase space debris. Space debris consists of artificial objects in space that have the potential of colliding or returning to Earth in an uncontrolled fashion. Such risks can pose a danger to the public if they are not prevented or mitigated.

The Saudi Space Authority has formulated its main activities concerning space debris based on several factors, including the safety of national assets and the safety

of Earth orbits. These activities can be summarized, but are not limited to, the following activities, which are updated as needed:

(a) Monitoring and tracking of Saudi satellites;

(b) Simulation of the paths of satellites in different orbits and prediction of collision risks;

(c) Monitoring and forecasting of the coordinates and timing of space objects that return to Earth;

(d) The work of a joint team established to respond to objects that return to Earth. The team comprises members of the relevant government agencies.

These activities are conducted around the clock in operations rooms, where data extracted from the simulation and tracking systems are analysed and assessed to generate periodic, real-time reports to help decision makers and satellite operators make proper decisions in this regard.

Saudi Arabia has local capabilities that allow it to monitor space. The King Abdulaziz City for Science and Technology has several local optical observatories that can be used to monitor objects returning to Earth and satellites in near-Earth orbit. Universities and research centres also have national observatories and observatories outside the Kingdom, such as in Chile and Morocco. The Kingdom is open to regional and international cooperation on outer space safety and the researching of relevant new technologies with United Nations programmes and government agencies (e.g. United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) and North American Aerospace Defense Command (NORAD)) and private concerns (e.g. LeoLabs and NorthStar). Several recommended space surveillance options have been evaluated to determine the best option for Saudi Arabia. These options include:

(a) Reliance on global surveillance networks;

(b) Establishment of a global radar surveillance network, which ensures independent space surveillance and the generation of a comprehensive database;

(c) International cooperation to establish an observatory in Saudi Arabia that is part of a global network, with access to the network database according to the agreement.

Several initiatives have been implemented to raise awareness of space risks, including space debris, in the scientific and civil society communities. They include conducting research and holding workshops with all segments of society. These initiatives, which serve the interest of space for humanity and prosperity, reflect the pivotal regional and global space role played by the Kingdom of Saudi Arabia as a member of the Group of 20 and the United Nations.

Saudi Arabia is expanding in the field of space in a way that ensures the safety of its interests, taking into account all international conventions and treaties. In summary:

(a) Saudi governmental and private agencies possess the scientific capabilities and infrastructure for monitoring space and space objects in various orbits;

(b) Saudi Arabia has developed space debris plans. It has prepared space debris reports and conducted workshops and research targeting all scientific and professional groups of society;

(c) Saudi Arabia is open to international cooperation on space debris with governmental and private entities;

(d) Saudi Arabia does not have any space objects carrying nuclear energy sources on board. All Saudi space objects are for peaceful and scientific purposes.

Slovakia

[Original: English]
[2 November 2021]

Validation of Slovakian optical sensor for space debris satellite laser ranging tracking support, object cataloguing and research

The Department of Astronomy and Astrophysics, part of the Faculty of Mathematics, Physics and Informatics of Comenius University in Bratislava, has improved the hardware and software of its 0.7 m Newtonian telescope (AGO70) through the programme for Slovakia under the European Space Agency Plan for European Cooperating States. The primary goal was to develop a space debris research instrument and space surveillance and tracking sensor able to observe objects located in all orbital regions, from low Earth orbits up to geosynchronous orbits. The capability of AGO70 to meet the defined objectives was validated during an observation campaign carried out in collaboration with the Austrian Academy of Sciences and the Graz satellite laser ranging (SLR) station in Austria, which was primarily focused on demonstrating real-time data handover between an optical passive sensor (AGO70) and active SLR sensors.

Application of the Slovak all-sky meteor network for re-entry event monitoring

The Faculty of Mathematics, Physics and Informatics of Comenius University is investigating the possibility of using its Automatic Meteor Orbit System (AMOS) camera system for space debris re-entry measurements. AMOS is used for automatic meteor detection, orbit determination and spectrum extraction. Comenius University developed and is now operating a total of 23 AMOS cameras worldwide, including spectral cameras, with 7 situated in the Slovak Republic, 3 in the Canary Islands (Spain), 4 in Chile, 3 in Hawaii (United States of America) and 6 recently deployed in Australia. The AMOS network detects re-entry events, which allows the Faculty to model the trajectories of created fragments in the atmosphere and to analyse their spectral properties. The analysis should lead to an improvement of survivability predictions for fragments and on-ground population risk estimates.

Space debris characterization through photometry and spectroscopy

The Faculty of Mathematics, Physics and Informatics of Comenius University is conducting several studies dedicated to the classification and characterization of space debris objects in order to better understand the origins and creation mechanisms of space debris. AGO70 is used to acquire light curves of space debris. Those data are used to identify the objects' reflectance properties and their size and shape. By using different spectral-type photometric filters, the Faculty is investigating the surface reflectance properties of space objects as a function of wavelength, which is directly related to material properties. AMOS spectral cameras are used to acquire specular glints and their spectra from objects in low Earth orbit. The acquired spectra provide high-resolution information about surface properties as a function of wavelength.

Ukraine

[Original: English]
[8 November 2021]

In Ukraine, research on space debris has been carried out by some enterprises and institutions for a long time.

Developments and offers by Yuzhnoye State Design Office[1]

Passive de-orbiting system: Low Earth Orbit Passive On-board Lightweight De-Orbiter

The Low Earth Orbit Passive On-board Lightweight De-Orbiter (LEOPOLD) can be made in various configurations (sphere and sail), and can be 1 m, 2 m or 4 m in diameter, depending on the initial orbit parameters, mass and dimensions of the satellite. The weight of the de-orbiter constitutes only a few per cent of the satellite's weight.

The main characteristics of the basic version (in a folded state) are as follows: diameter: 1 m; weight: up to 1 kg; dimensions: 1U (10 cm x 10 cm x 10 cm). The system characteristics are low cost, high reliability, low weight, compact design and survivability against small space debris impacts.

Active de-orbiting system: spacecraft interceptor with capturing modules

The spacecraft interceptor is designed for the effective de-orbiting of medium-sized space debris objects from low Earth orbits (up to 1,000 km). The system includes the spacecraft interceptor, equipped with a set of modules for capturing and deorbiting space debris objects, and a ground control station.

Institute of Technical Mechanics

In 2021, the Institute of Technical Mechanics (ITM)[2] carried out research projects on the development of the construction scheme of an artificial magnetic field source for the magnetohydrodynamic braking of a space debris object in the Earth's ionosphere and on the mini-magnetosphere as a means to control spacecraft motion in Earth's ionosphere by using its self-magnetic field and the efficiency basis of near-Earth space cleaning technology for space debris objects (experimental and theoretical research).

As part of those research projects, in creative cooperation with the Yuzhnoye State Design Office, the principles of the transfer of space debris objects from high to low orbits using electromagnetic force that occurs when the on-board source of a permanent magnetic field interacts with near-Earth plasma are being developed. The scheme of assembling a compact on-board magnetic field source with an induction of 0.8 T to 1 T using specially arranged neodymium mini-magnets is being developed.

In particular, the transfer of the space debris object Vega Secondary Payload Adapter (100 kg, in orbit since 2013) from 660–800 km to 150 km with subsequent combustion in the dense layers of the Earth's atmosphere can be performed in 100 days using an on-board permanent magnetic field source of 0.8 T to 1 T. Experiments on the plasma electrodynamic stand at ITM, a scientific device that has the status of "national heritage of Ukraine", proved that the prototype source of a permanent magnetic field creates an electromagnetic force in near-Earth plasma at an altitude of 700 km that is capable of transferring space debris objects to an altitude of approximately 100 km in the given period of time, with subsequent combustion in the dense layers of the Earth's atmosphere.

In addition, in 2021, the problem of near-Earth space pollution is being studied at ITM within the scientific work on the development and improvement of methods of system analysis, control and study of dynamics directed at the creation of space technological objects. The following should be determined at the end of the year:

(a) The state of application of mathematical methods for modelling space debris motion. Possible ways to increase the accuracy of statistical methods for modelling the motion of large fragments of space debris will be established and implemented;

[1] www.yuzhnoye.com.

[2] www.nas.gov.ua.

(b) The condition and problems of the development of orbital industrial complexes (including space debris recycling) and methods of optimizing their design parameters;

(c) The main tendencies and ballistic problems of the development of orbital services for space industrial complexes;

(d) The problems of method applications for cases of spatial position control of uncooperative objects of on-orbit service (including space debris objects) relative to the spacecraft;

(e) The problems of application of known methods for on-board determination of parameters of spatial motion for on-orbit servicing of objects relative to the spacecraft.

National Space Facilities Control and Test Centre

During April and May 2021, the National Space Facilities Control and Test Centre (NSFCTC) [3] took part in an Inter-Agency Space Debris Coordination Committee (IADC) project aimed at calculating and forecasting the lifetime and the probable area of re-entry into the Earth's atmosphere of the space objects Starlink-26 (2019-029F; 44240) and CZ-5B (2021-035B; 48275). The calculations were posted on the organization's website.[4]

During 2020 and 2021, NSFCTC optical equipment was used in the IADC campaign for photometric observations of low Earth orbit upper stages. During the campaign, 133 light curves were obtained for eight objects. According to the conditions of the observation campaign, the information will be provided to the coordinators of the campaign in December 2021.

NSFCTC personnel carry out daily calculations of dangerous approaches between space objects with on-board nuclear sources. As of 20 October 2021, 530 dangerous approaches at a distance of less than 1.5 km had been identified in 2021. In addition, NSFCTC personnel carry out daily calculations of the lifetime of space objects and calculations of the possible re-entry and impact areas of space objects (satellites that have ceased to exist).

[3] https://spacecenter.gov.ua.

[4] https://iadc-redb.esoc.esa.int/iadcredb/.