Space Debris: Discussion in the Scientific and Technical Subcommittee

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Introduction

A deep satisfaction to have the important item on Space Debris on the agenda was expressed by many delegations at the 37th session of the Scientific and Technical Subcommittee, held in Vienna from 6-17 February 1995. It was already the second year of discussions of space debris, this time as one of the priority items.

The following delegations took part in the discussion of space debris: Canada, USA, Czech Republic, Germany, Japan, Argentina, Indonesia, Chile, Philippines, United Kingdom, Russia, Poland, India, France and China. Many scientific and technical issues were tackled. Additional observations and cataloguing of space debris was advocated, as well as more work on modelling of the debris environment and on the study of hypervelocity impacts. Some delegations stressed the difficulty of observing small debris at high altitudes and the incompleteness of lists of catalogued debris.

Some delegations wished to have a better access to data on orbital data of debris[2]. It was also considered desirable to have access to detailed data on models of the debris population. Several scientific institutions work intensely on this problem. It can be expected that within a short time such models will be widely accessible.

Concern was expressed on adverse effects of space debris on the environment and, in particular, on the safety of space missions.

The Subcommittee took note of many programmes of Member States on the scientific and technical aspects of space debris, such as the ODERACS spheres for testing the sensitivity and efficiency of methods of detecting space debris. It heard also scientific and technical presentations on space debris by prominent experts from the International Astronomical Union. France, Poland.the European Space Agency, India, and the United Kingdom. The Subcommittee also noted the formation of the Interagency Orbital Debris Coordination Committee (IADC) in 1993. Its members[3] will exchange information on space debris activities and discuss debris mitigation measures.

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[2]Perhaps it is not widely realized that data on objects in space. listed and computed by national agencies, can be accessed through the computer network INTERNET. This concerns, e.g. lists of objects in the geostationary orbits, lists of all objects published in the NASA Satellite Situation Report and other data.

[3]NASA, ESA, NASDA and the Russian Space Agency, RDA

Some delegations proposed the adoption of a Global Management Plan for Space Debris, while other delegations provided information on governmental policy statements intending to promote the prevention, to the maximum extent possible, of the generation of space debris.

Summing up, the Subcommittee felt that it was necessary to establish a firm scientific and technical basis because the phenomenon of space debris is quite complex. The elaboration of a multi-year work plan was considered desirable for this purpose. Some delegations were of the opinion that it was not appropriate to move the discussion to the Legal Subcommittee at this time. A proposal put forward by one delegation, to state which objects fall into the category of space debris failed to receive a wider support.

The work plan

The Subcommittee, as a follow-up of last year's decision, supported the elaboration of a work plan for the future. Based on several proposals, the Subcommittee adopted the following work plan for the next three years:

1996: Measurements of space debris, understanding of data and effects of this environment on space systems

Measurements of space debris comprise all processes by which information is gained through ground- and space-based sensors. The effect (impact of particulates and resulting damage) of this environment should be described.

1997: Modelling of space debris environment and risk assessment

A space debris model is a mathematical description of the current and future distribution in space of debris as a function of its size and other physical parameters. Aspects to be addressed are:

- Analysis of fragmentation models
- Short- and long-term evolution of the space debris population
- Comparison of models.

The various methods for collision risk assessment should be critically reviewed.

1998: Space debris mitigation measures

Mitigation comprises reduction of the space debris population growth and protection against particulate impact. Measures for the reduction of space debris growth include methods for debris prevention and removal.

Protection against space debris includes:

- Physical protection with shielding
- Protection through collision avoidance.

Current operational debris mitigation practices should be reviewed at each session and future mitigation measures should be considered with regard to cost efficiency.

The work plan has to be implemented with flexibility. It was also agreed that topics not in the work plan may be addressed by delegations wishing to do so.

Technical presentations

Prof. Derek McNally, former General Secretary of the International Astronomical Union, reported on Adverse Environmental Impacts on Astronomy[4]. One of the important adverse impacts on astronomy comes from space debris which contaminate astronomical photographs and may compromise the scientific value of unique photographs. He said that space debris must be accepted at present just as people had to accept bad weather.But it is very encouraging that space debris are now being discussed at the UN. He warned that deep sky astronomy would die and the rest of astronomy would be compromised out of existence should commercial advertising in space be implemented since the night sky would be illuminated.

Dr. Yves Trempat, Deputy Director of the National Centre for Space Studies, Toulouse, France, reported on experiments conducted in France on space debris and on modelling of the space debris environment.

Dr. Walter Flury of the European Space Agency advocated the adoption of a multi-year work plan because it would provide a thorough understanding of the debris environment, its future evolution with regard to the expected level of space activities and the risks posed to active space systems. He discussed also protection measures for satellites and measures to restrict the amount of newly generated debris.

Prof. Edwin Wnuk of the Astronomical Observatory of the Adam Mickiewicz University, Poland, showed that the present knowledge of the gravity field of the Earth does not allow to determine future positions of space debris with the required accuracy. Future research should be oriented to acquire a more detailed knowledge of the field of attraction of the Earth.

Mr. M.G. Chandrasekhar, Scientific Secretary of ISRO, India, reported about studies of the dynamics of explosions of spacecraft, the number of fragments which are generated and their distribution in space.

Dr. Richard Crowther of the Defence Research Agency of the United Kingdom expressed his support for the technical definition of orbital debris (see IAA Position Paper on Space Debris): "Orbital debris is any man-made earth-orbiting object which is non-functional with no reasonable expectation of assuming or resuming its intended function, or any other function for which it can be expected to be authorized, including fragments and parts thereof". Dr. Crowther also suggested that conditions for a survivable environment in outer space should be elaborated.

Collisions of space objects

The General Assembly Resolution 49/34 called for paying more attention to collisions of space objects, including those with nuclear power sources, with space debris. This topic was discussed by the Subcommittee under the item

[4]A colloquium on that subject was sponsored by UNESCO, the International Council of Scientific Unions, the International Astronomical Union and the Committee on Space Research. It was held at UNESCO, Paris, 30 June-2 July 1992. Proceedings published: The Vanishing Universe, ed. D. McNally, Cambridge University Press, 1994.

on the Use of Nuclear Power Sources in Outer Space, as well as under the item on Space Debris. The information provided by Member States on that subject appeared in the document A.AC.105/593 and Add. 1,2, and 3. The Subcommittee agreed that national research on space debris should continue.

Debris in the Geostationary Orbit

A technical presentation by Peter Korobenkov of the Radio Communication Bureau of the ITU dealt with, i.a., a recommendation[5] adopted by the ITU Radiocommunication Assembly in 1993. It was recommended

1. that as little debris as possible should be released into the geostationary orbit (GSO) during the placement of a satellite in orbit;

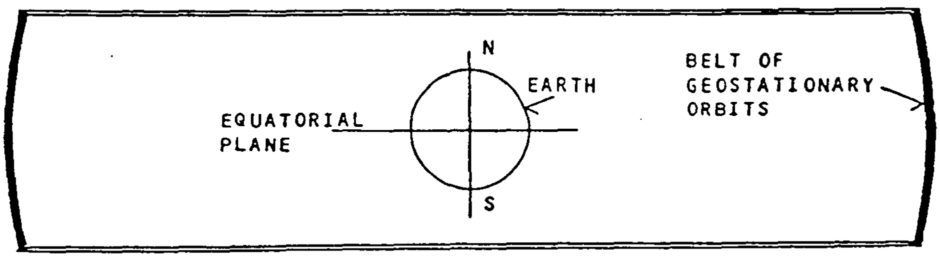
2. that every reasonable effort should be made to shorten the lifetime of debris in the transfer orbit;

3. that a geostationary satellite at the end of its life should be transferred, before complete exhaustion of its propellant, to a supersynchronous graveyard orbit that does not intersect the GSO;

4. that the transfer to the graveyard orbit should be carried out with particular caution in order to avoid radiofrequency interference with active satellites;

The document also stated that further studies are required to define what constitutes en effective graveyard orbit[6].

An Annex to the above recommendation, entitled "Environmental protection of the geostationary-satellite orbit", deals with the physical aspects of objects in the geostationary orbit. It contains also a definition of the GSO: "For purposes of considering environmental measures, the GSO may be defined as the mean earth radius of 42 164 km ± 300 km and extending to 15° N/S latitude or a distance of approximately 10 000 km". A geometrical illustration of that definition is shown in this diagram:



A brief discussion followed, concerning the relation of that definition with views and working papers presented at earlier sessions on that subject.

[5]Recommendation ITU-R S.1003. UN document A/AC.105/C.1/CRP.4 of 9 February 1995

[6]The term "graveyard orbit" is equivalent to the term "disposal orbit" used in several studies and UN documents.

The above recommendation marks the first time that the ITU dealt with objects in space *not transmitting radiocommunications.* It may be of interest and of importance to consider that recommendation in context with new technical developments. What comes to mind are plans for using low Earth orbits for communications, such as the Iridium project or the Mega-LEO satellite system. Both projects call for large numbers of satellites in low orbits. It cannot be excluded that the ITU, in an effort to protect active communication satellites, might discuss, at some time in the future, also space debris at low orbits.

Factual information on space debris

The literature on space debris has exceeded, by estimate, one thousand scientific and technical papers. An interested reader will find, however, most of the information in a few authoritative studies. Such is, e.g. the Position Paper on Space Debris by the International Academy of Astronautics[7], or the study on Space Debris by the European Space Agency[8], or the study prepared for the US Congress[9]. The history of space debris activities has been reported in a very useful NASA document[10].

As regards terminology, two terms have been used in the discussion and in the documents: "space debris" and "orbital debris". Both terms refer to the same objects. "Orbital debris" refer to the objects while they are in orbit, i.e. before they re-enter the dense layers of the atmosphere or eventually impact on the ground or on the surface of the ocean. The term "space debris", used in the General Assembly Resolution 43/94, is not necessarily subject to the same restriction.

[7] Appeared in the documents A/AC.105/570, A/AC.105/593, p. 22-43, and was distributed as a brochure at the session of the Scientific and Technical Subcommittee.

[8] Space Debris. The Report of the Space Debris Working Group. ESA SP-1109, November 1988.

[9] US Congress, Office of Technology Assessment, Orbiting Debris: A space Environmental Problem - Background Paper, OTA-BP-ISC-72, September 1990.

[10] David S. F. Portree, Josef P. Loftus, Jr.: Orbital Debris Near Earth Environmental Management: A Chronology, NASA Reference Publication 1320, December 1993.