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THE ONGOING IAA STUDY ON PROTECTING THE ENVIRONMENT OF CELESTIAL BODIES (PECB):

THE CONCEPTUAL BACKGROUND AND INTERMEDIATE RESULTS

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ABSTRACT

Intensive activities on the Moon and an increase of man-made objects to be sent to Mars can be expected over the next decade and will result in a growing risk of damages to the natural environment of the celestial bodies concerned. The ongoing IAA Study on "Protecting the Environment of Celestial Bodies" (PECB) has been initiated in order to address this development and to respond to the most pressing questions related to it. It was kicked off in 2007 and is intended to end in 2010. The Study uses a multidisciplinary approach to analyze related issues and to identifying possible solutions which would be acceptable to the international community. The study team developed the first draft chapter texts by July 2008. It can be noted that the present planetary protection (PP) approach is highly developed and performed by several space faring countries, but, however, focused on scientific exploration activities. Space faring nations seem not interested in an appropriate binding norm of international law. The next steps of the Study will focus on the analysis of potential multidisciplinary measures and, possibly, the development of a set of recommendations for a comprising approach to the protection of the environment of celestial bodies.

1. MOTIVES AND SCOPE OF THE STUDY

Space activities bring undoubtedly a wide range of benefits to humankind –in science, technology, economy and many other areas. Like all human activities, they leave *per se* more or less measurable traces in the space environment. Some special forms of this phenomenon - the issue of space debris or the problematics of biological contamination - have been analysed in the space community already. Individual studies have been devoted to other questions such as the issue of abandoned objects in planetary orbits or the environmental impact of planned planetary mining or human settlements, however, the space community as a whole has not considered them of particular importance until now. It can be stated that the issue of protection of planetary environment has not met any systematic, international and multidisciplinary approach yet.

The example of Earth-bound environmental problems and their currently hardly manageable range shows how difficult it is to cope with the detrimental consequences of human activities in comparison with preventive measures to avoid them. Even if the precautionary steps might be expensive and time consuming, economy teaches that at a certain point in time they prove less demanding than the cleaning measures later.

The IAA Study on Protecting the Environment of Celestial Bodies aims at providing an overview of existing methods

of planetary protection and their efficiency from the perspective of current and future needs – biological, technical, legal, economical and other methods. By doing so, it goes deliberately beyond the interpretation of "Planetary Protection" by COSPAR (Committee on Space Research), which is generally used as a set of methods used for protecting the planets from *biological* contamination avoiding compromising future exobiological research. Because of the limits given by the planned volume of the study, it concentrates mainly to the Moon and Mars environment.

Its general goal is not necessarily the draft of a new, formal international document, because the required knowledge and international consensus is missing at this stage. The ambition of the study team primarily is to initiate an international discussion and to raise awareness of the whole spectrum of the issues connected with the protection of the environment of celestial bodies, and in deliberating ideas how to organize this protection more efficiently on international scale. Depending on the findings during the study, a proposal of a code of conduct "how to avoid future pollution of environment of celestial bodies" might be developed at the final stage of the project.

2. THE ORGANIZATION OF THE WORK

The interdisciplinary character of the subject of the study requires a research done by a **multidisciplinary team**. The chairs and the secretary of the study challenged many prominent authors active in the field of Planetary Protection. Until now, nine authors have delivered their contributions to the study: Ivan Almar, Hungary (What Could Cospar do for the Protection of the Planetary and Space Environment?), Cassie Conley, USA (Current planetary protection activities), Petra Rettberg, Germany (Currently applied methods for bioburden measurements of spacecraft – are they sufficient?), Gernot Groemer, Austria (Mars Astrobiology: Introductory Aspects and Context), Mahulena Hofmann, Czech Republic and Germany (Is there any Legal Regime for the Protection of the Moon's Environment?), Francis Lyall, UK (Environmental Regulations of and in Outer Space), Annelie Schoenmaker, The Netherlands (The Potential of Education and Media as Instruments for Planetary Protection), Kazuto Suzuki, Japan (Potential of Politics for Protecting the Environment of Celestial Bodies), Mark Williamson, UK (Protection of the Space Environment: the Advantage of an interdisciplinary Approach), and Vasilis Zervos, Greece (Instruments of the Protection of the Environment of Celestial Bodies: The Potential of Economy).

The study team is an open group and is currently working on the initial draft text. Therefore, experts that have interest in participating are invited to contact the co-chairs or the secretary.

The study has been performed in several **steps**: It has been accepted by the Commission V of the International Academy of Astronautics (IAA) and was approved by its Scientific Activity Committee (SAC) in spring 2007. The first step has been the definition of key questions related to the protection of celestial bodies which took part mostly during the Kick-off Meeting at the occasion of the 58th International Astronautical Congress in Hyderabad, India. The present study team has been formed in the first half of 2008. After the distribution of the relevant themes among the potential authors, first drafting work for each chapter has started in spring 2008. The 2008 Glasgow IAF Congress will serve as a platform for presenting and discussing the very first results from the work begun and the steps to follow. The first draft of the study will be presented in the IAA and at

the IISL session connected with legal issues of the environmental protection. Until March 2009, the texts of the chapters will be finalized, in order to enable to draft the part "Proposals and Recommendations" on their basis until March 2009. The team plans to meet again at the IAC 2009 in Daejon, South Korea and submit the final version to the IAA afterwards. The final Cosmic Study is intended to be published in 2010.

3. PRELIMINARY RESULTS

3.1. The Challenges for the Environment of Celestial Bodies

In their contributions, the members of the study team have identified several challenges for the environment of celestial bodies:

A significant amount of space debris has already contaminated the surface of Moon, Venus and Mars. The spacecraft populations in orbital environments of planetary bodies, notably the Moon and Mars, are already on the rise. Commercial space tourism is increasing and so is its environmental impact. Industrial activity, mining in particular, may destroy the original environment of smaller celestial bodies. The commercial endeavors can evolve very quickly. Each research, also in-situ research, is always producing a certain amount of pollution. More planetary protection issues and risks will arise with the addition of the human component to the planetary missions: neither space suits nor space habitats will be closed systems; cross contamination will be reduced, but not fully avoided – at least at the landing and habitat site. Any permanent base on a celestial body can be a source of pollutants which can destroy or degrade in-situ research. Developing space based energy sources, including in-situ fuels for use in space or transfers to Earth, can affect the planetary environment detrimentally. Colonization and terraforming mean a large scale transformation of the environment – the reforming of the environment of a planet to accommodate human life. Polluting planetary space can have harmful effects also to astronomy. Space based weapons would be damaging the space environment.

3.2. Instruments of the Protection of the Environment of Celestial Bodies

Following instruments of protection of environment of planetary bodies have been identified by the members of the study team:

For a long time, the tendency to concentrate on biological protection of potential life forms on planetary bodies against contamination form spacecraft has dominated this field; other aspects of protection have been sidelined. The wide range of the activities which can have detrimental effects on the environment of celestial bodies requires a **consolidated, interdisciplinary approach** to this issue.

Historically, the protection against **biological contamination** is the most experienced form of protection of planetary bodies. The activities concentrated so far on the avoidance of contamination with viable organisms, but also contamination with organic / biochemical compounds is already addressed. The aim of these planetary protection activities is exclusively the enabling of future scientific investigations of possible extraterrestrial life forms, precursors, and remnants without any environmental pollution resulting in the misleading interpretation of scientific results. These activities are organized the **COSPAR** since the sixties when it was charged to work on the planetary quarantine prescriptions. Based on its survey, a list of the most important/ interesting planetary environments of a classification scheme for territories with gradually decreasing interest for science

should be established (space wilderness areas). In October 2002, COSPAR has formulated the present **Planetary Protection Policy** which embodies a set of **guidelines and recommendations** based on Article IX of the Outer Space Treaty; the last amendment to the policy was adopted in July 2008. The intensity of measures the states have to take during their space activities varies according to the category of the target body (e.g. Mars, Venus, and Moon) and mission type (e.g. flyby, orbiter, lander, and rover). The Policy understands the environment of the Moon as a part of the Earth-Moon system; in general, it must be protected from back contamination to fulfill planetary protection requirements on Earth-Moon travel. However, in 2008 the Moon was reclassified into another category (PP category II) which requires simple documentation to outline intended or potential impact targets, brief pre- and post-launch analyses and an organic inventory.

The COSPAR members are recommended to provide information to COSPAR within a period not exceeding six months after any launch about the procedures used for planetary protection for each flight and again within one year after the end of a solar-system exploration mission about the areas of the target(s) which may have been subject to contamination. COSPAR will make a repository of these reports; make them available to the public, and annually delivers a record of thee reports to the UN Secretary General.

The acceptance of the COSPAR rules is high in the solar system exploration community. In the European sphere, they have been implemented formally by the definition of the **ESA planetary protection policy** together with related requirements and procedures in 2007. The European Cooperation for Space Standardization (**ECSS**) is a normative system jointly elaborated by European space agencies and companies. The goal of standards defined by ECSS working groups is to guarantee that the entire European space community works under the same rules and same procedures – not only ESA member states but also organizations from non-member states involved in ESA missions or launched from launching pads located in the territory of an ESA member state. A set of standards aimed at the application of appropriate methods and procedures for biological and chemical contamination control is under development.

In addition to international and European standards, the COSPAR recommendations have been implemented by national systems, such as **national standards** issued by the CNES or NASA.

The specific feature of the COSPAR rules is that they are focused strongly on the issue of scientific investigation of possible extraterrestrial life forms ("The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized"). Materially, they do not concern the question of a simple "use" or "exploitation" of outer space. The measures in stake should be reported only after the completion of a mission. These rules are of a recommendatory character, the compliance with their content is therefore only voluntarily. Their significance as "best practices" rules broadly accepted in the scientific community cannot be underestimated.

Other instruments of planetary protection are or can be focused on the protection of specific areas of outer space, such as **Mars**. It shows that contamination vectors during a crewed surface sojourn are unknown due to uncertainties in the exploration procedures, tools to be used and areas to be explored. Currently, there is a paradigm in place not to allow humans to access the astrobiologically most interesting regions in observance of the

planetary protection measures set forth by COSPAR. At the same time, it is generally recognized that limiting subsurface sampling activities only to robotic drilling and analysis systems put severe constraints on the reachable soil depth and sample procurement. Thus, proper sample procurement protocols have to be elaborated to reduce cross contamination on the basis of further simulation missions.

In addition to the methods of biological contamination control driven by scientific interests, the scale of the influence of space activities on the environment of celestial bodies can be influenced by the instruments of **economy**: Cost is an obvious automatic mechanism for the protection of much of the environment both on the Earth and celestial bodies. The potential discovery of minerals on celestial bodies might lead not only to rethinking the concept of "common benefits" and allocation of resources but also to new approaches to the sharing the environmental burden. The even more meaningful way how human activities can affect the environment of celestial bodies – their habitation - allows several scenarios: The variant that the pollutant continues to pollute and compensation is too ineffective and risky. A decisive moment in this model is the dynamic element of colonial expansion: from a certain number of inhabitants, it is most costly to first pollute and then be in need to clean, rather than utilizing the clean technology from the beginning.

The **law** attempts to prevent the detriment of space environment since the 1960s. Until now, there are three specific provisions dealing with this issue: Article IX of the Outer Space Treaty obliges the states to explore and use the Outer Space with due regard to corresponding interests of other states (due diligence principle). Further, states shall pursue studies of Outer Space, including the Moon and other celestial bodies, so as to avoid their harmful contamination and, if necessary, adopt appropriate measures for this purpose. The next special provision is Article 7 of the Moon Agreement prohibiting to explore and use the Moon and other celestial bodies in a manner disrupting the existing balance of their environment; the states parties are obliged to take measures preventing such impact of their activities.

The well known problem of these provisions is the fact that they are too vague or too narrow in case of the internationally reputable Outer Space Treaty or binding only a minimal number of states in case of the Moon Agreement. There does not exist any specific, generally binding and enforceable provision prohibiting deteriorating the environment of celestial bodies by both their exploration and exploitation. This rule can be, however, deduced from general international law: A general international duty towards the preservation and conservation of the environment, both within and outside areas of national jurisdiction is developing, primarily through the International Court of Justice (ICJ) case law. This developing international Law on the environment is not confined to the post hoc action: The Precautionary Principle which originates in municipal law is making its way in international law. In relation to space activities, harm done to "generations unborn" as the ICJ put it, could well include the degradation of the space environment, both near and far. However, further deliberation has to be devoted to the question as to who is entitled to bring an action to enforce a duty owed to many or to the population as a whole.

Politics as a process of people seeking and using power to realize their objectives helps to understand that if one seeks to limit the behavior of a state or individual to contaminate celestial bodies, there should be a person or an entity who has enough power to set up a rule or law for protection the environment of celestial bodies.

However, there are a very limited number of states capable of exploring celestial bodies and having power to establish international standards. Additionally, there is no current consensus or normative understanding among these states with the respective capacities. The lack of "power" for enforcing environmental criteria is multiplied by the fact that there is no effective governing body of space activities; there are bodies such as UNCOPUOS and OOSA (UN Office for Outer Space Affairs) which may act as governing body, but there is no power in these institutions for enforcing the rules for rule-breakers. Constructivist arguments, which explain that actors behave according to what they believe is good or appropriate, lead to the presumption that it is necessary to construct viable ideas and discourse which would convince all states to protect the environment of celestial bodies.

The awareness of the necessity to prevent the deterioration of the planetary environment can be raised by several means, which also include **education** and **media**. Education is meant to inform the public on this sensible issue and to create public opinion. Public opinion can make a difference, for example for political pressure, especially in space exploration where passion and fear easily appear. In this area, a number of initiatives have already started – e.g. regular joint courses by ESA and NASA on planetary protection policies and practices to familiarize current and future practitioners with the COSPAR planetary protection policy and guidelines. The presentation of the respective policies in media targets at journalists and the general public: all media tools – such as specialized journals, general publications, or the internet can be used in order to spread information and awareness on planetary protection issues. The way forward would be to elaborate a communication plan aimed at promoting the results of the IAA study and the topic in general to make education and media coverage happen.

4. CONCLUSIONS

At the present stage of the IAA study, a lot of important information on present approaches to planetary protection, its gaps and future concepts has been collected and analyzed. This information enables to draw the conclusion that the present planetary protection approach is highly developed by several space faring countries, internationally coordinated and duly performed.

On the other hand, it cannot be overlooked that this system bases on recommendatory and posteriori rules, is focused on scientific exploration activities and does not handle the possibility of deterioration of environment of celestial bodies by their exploitation or human settlement. However, in the latest version the COSPAR Planetary Protection Policy principles and guidelines for human missions were already outlined by the statement that a comprehensive planetary protection protocol for human missions should be developed. It should encompass both forward and backward contamination concerns, and address the combined human and robotic aspects of a mission, including subsurface exploration, sample handling, and the return of the samples and crew to Earth.

If there are more comprehensive national concepts of prevention of planetary environment by space activities, they have not been included into any general international network until now.

The present knowledge of the situation allows also a conclusion that the space faring countries do not show any apparent interest to be bound by an appropriate binding norm of international law which would make them internationally

responsible for environmental failures. The elaboration of a new, recommendatory document (UN resolution) encompassing such a rule does not seem to be of any immediate use for them.

The next steps of the IAA study should, therefore, focus on raising awareness in the space community about the fact that a common approach in avoiding the deterioration of space environment would be of general interest for pursuing sustainable long-term science and exploration programs (also involving e.g. countries with only potential space programs); it should be evaluated, whether the planetary protection authorities of space faring countries would be willing to assist in the creation of an international network for exchange information about protection issues. Additionally, the content and potential of present international general law obliging states to ensure that activities within their control respect the environment of areas beyond their national control should be further elaborated in context with space activities. At the final stage of the project, a set of recommendations aimed at the protection of the environment of celestial bodies might be developed, depending on the findings during the preceding steps of the study.