MUST SPACE MISSIONS BE BENEFICIAL ?

Luboš Perek*
Astronomical Institute
Czechoslovak Academy of Sciences, Prague

Abstract

The Outer Space Treaty states that the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries. A mechanism for consultations has been provided in case different countries have different views on what is beneficial.

There is, however, no mechanism for solving possible differences of opinion if one or both parties to the dispute are not states but other entities, such as communities of scientists or artists, or organizations wishing to commemorate an event, or private business wishing to meet an existing or imagined need of the public.

Proposals have been put forward in the past for several space missions providing questionable benefits to mankind or irreparably changing the space environment. The real danger of such projects is not in proposing them because a grain of truth may be in any product of human imagination. The danger lies with official agencies reviewing and approving space projects on formal grounds only without taking into account all implications and without realizing that the consequences of their decisions may be with us much longer than anything else that mankind ever produced.

1. Introduction

In the preamble as well as in Article I of the Outer Space Treaty[1] the rule was expressed that the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic and scientific development, and that it shall be the province of mankind.

The above idea has a very high moral value and deserves its place in the first article of the first instrument of space law. In practice, however, such a general benefit hardly can be realized because what is beneficial to one country may be deleterious to another country . Therefore, Article IX states that space activities shall be carried out in the spirit of cooperation and mutual assistance and shall be conducted with due regard to the corresponding interests of other State Parties to the Treaty. If a State Party has reason to believe that its activity or experiment would cause potentially harmful interference with activities of other State Parties, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. Such consultations may be requested also by State Parties having reason to believe that an activity or experiment planned by another State Party would cause potentially harmful interference with activities in the peaceful exploration and use of outer space.

2. Clash of interests

The possible clash between benefit and harmful interference as two sides of the same phenomenon may be more general than just between two countries. It may arise between two agencies, one a launching agency, the other an agency using space applications. The freedom of the former to generate debris may compromise the freedom of the latter to use the benefit of continuous service of a space application. Or, a possible clash may arise between the launching industry and the community of astronomers whose freedom of investigation at ground based observatories depends on favourable observing conditions. They may put up with the hundreds of active and generaly useful satellites but not with the thousands of nonfunctional objects. Their traces on the night sky may make important observations worthless and, in general, may compromise our view of the Universe.

*Member IAU, IAA, IISL.

What about space missions satisfying few but inconveniencing many? Do they have to be treated on the same footing as widely beneficial missions?

3. Commemorative missions

An example: Plans have been put forward[2] to celebrate in 1989 the centennial of the Eiffel tower by launching a commemorative space structure. A competition was announced for a space object visible from as many points on the ground as possible, and symbolizing universal communication. Ninety projects were submitted, some attaining wide visibility by choosing a polar orbit, some by choosing the geostationary orbit. The three winning projects stressed the symbolic nature of the Eiffel Tower, such as the ring of unity, the human star, or the space beacon with a message of hope.

The first project consisted of one hundred inflatable spheres, each of $6m$ diameter, appearing as a ring of stars of magnitude +1 traversing the horizon in about 10 minutes. Its altitude at $800km$ would make the ring about the same size as the Moon and its lifetime not more than 3 years. A device could severe the connections between balloons and set them free at any time.

The second project, ARSAT, was a square sail of $60m$ diagonal of a maximum brightness of magnitude -5.5. ARSAT would be above the horizon about 20 minutes at each passage with 5 minutes of maximum brightness. No data were announced about the expected decay or number and sizes of debris.

The idea of commemorating an outstanding technical feat is highly commendable and the question arises: should such an idea be supported at the cost of a fairly large number of debris and at the cost of forcing astronomers to interrupt their observations for a certain time at each passage through, or close to, their line of vision? Imagine an analogous situation on the ground. Someone could propose the construction of a monument to a most deserving personality and to place the monument in the middle of a highway to make it visible to every driver. Would the public tolerate such a threat to safety? Would it not be preferable to place the monument in the centre of a park where it could be enjoyed at leisure?

4. Orbiting Cemetery

Many projects have been proposed and many more will be proposed in the future ranging from beneficial with a grain of grotesque to grotesque with a grain (or without a grain) of beneficial.At the bottom of the scale are projects which went first under the name of Urnsat, later Celestis-Space Services[3], to launch cremated human remains into Earth orbit with a guaranteed long lifetime. The generations succeeding those cremated and launched would know that their ancestors are still moving overhead and posing a hazard to the lives of astronauts. What a cruel and unusual punishment beyond anything Dante Alighieri could think of in his Comedia Divina! The point is that at one time this project was seriously considered and was close to approval by an official agency.

5. Solar option

There may be other projects, useful to many but having disastrous consequences on environment or science, in particular on astronomy. Let us give the following examples:

In the 1970's the solar option was proposed by K.E. Ehricke[4] to place reflectors in suitable orbits to beam to the Earth measured amounts of sunlight. Areas of the ground were to be irradiated with a brightness ranging from less than the equivalent of the full Moon to the Sun's brightness. The main task was warming and cultivating polar land masses, keeping shipping lanes free of ice, night frost prevention, precipitation control, night illumination of large cities etc.

The smallest, Lunetta, would provide an illumination from 1 to 1000 Moon equivalents from highly inclined sun-synchronous orbits, to areas of about $32km$ diameter at northern latitudes or in the Antarctica between 60° to 80°. A larger project, called Agrisoletta operating from the same kind of orbits would use reflector units of $5-10km^2$ and provide 0.2 to 0.6 solar constants to the ground. Powersoletta uses sun-synchronous orbits of about 3 hours period, concentrating one solar constant on solar power plant receivers on the ground. The system uses $5-12km^2$ units with a total reflecting area of over $10,000km^2$. Biosoletta would operate from a distant orbit, e.g. the geostationary orbit, would have reflector units of

$70-100km^2$ and a total area of up to $100,000km^2$, providing an energy of one solar constant to the ground.

The whole system has been thought through to a great detail, from orbits, to atmospheric effects (of effects of the atmosphere on the project, not of the project on the atmosphere), to reflector coating, supply requirements, to favourable estimates of per capita costs. It is concluded that "space light systems are virtually indestructible, global in their beneficial services and no conceivable threat to anybody". Only the impact of the system on the environment, on the balance of natural systems, on effects of heating of high latitude areas on systematic melting of ice, has not been considered. And, surprisingly in a work of so much technical detail and so many applications of celestial mechanics, no mention of astronomical observing conditions. Perhaps the late 1970's were the last moment where such a disregard of environmental impacts was possible.

6. Satellite Power Systems

Solar option is subject to one important disadvantage. The attenuation and dispersion of light by cloud cover could locally decrease the effectiveness of the system by a large percentage. This disadvantage has been removed by another project, the Satellite Power Systems, originally proposed by Peter Glaser[5] in 1968:

The low density solar energy in space is collected by solar-cell arrays mounted on satellites in the geostationary orbit, the electric current is transformed to microwaves and transmitted to the ground. Microwaves penetrate the atmosphere under all-weather conditions. On the ground, they are collected by very large rectangular antennas and converted to electrical energy.

A solar-cell array of $5 \times 10km$ would deliver $5GW$ of power to the utility grid. The receiving antenna on the ground would have dimensions of about $10 \times 13km$ at 35° latitude. The satellite is constructed in the geostationary orbit. The material and personnel required for construction are transported to orbit by electrical or chemical propulsion vehicles.

A NASA study[5] contains an environmental assessment of public exposure to microwave radiation, of occupational exposure, of various ecosystems, such as free-flying species, of atmospheric effects. As regards effects on astronomy, it was found that SPS satellites would be as bright as the planet Venus at its brightest. Increased sky brightness from sixty SPS satellites would prevent effective optical observations of faint light sources in a band 10° wide and would interfere with faint airglow studies. Specular reflections from polished surfaces of the satellites would present another hazard. Radio astronomy would probably be affected by sidelobe radiation of the microwave beam.

The geostationary orbit accommodates at present a relatively large number of communication satellites and a few satellites for meteorology, remote sensing, scientific experiments, etc. Should, however a dense network of solar power satellites be envisaged for the geostationary orbit, harmful interference would have to be prevented by a thorough co-ordination of communication links of all space systems in the geostationary orbit. If coordination could not solve all problems of interference, the geostationary orbit would have to be reserved either for the SPS or for the present applications.

7. Conclusions

Evidently, the usefulness of space missions should be considered together with their possible pollution of the space environment and adverse impacts on other space systems and on other fields of human activities. Anybody should be free to put forward any proposal for a space mission but a higher authority reviewing and approving the project should not act on formal grounds only but should take into account all implications. It has to be realized that the consequences of such decisions could be with us and our posterity for much longer than anyting mankind has produced up to now, including the Great Wall or the pyramids.

The difficult point is, who is to make the decision that a project is beneficial in the spirit of the Outer Space Treaty? Let us have a look at fields where vehicles owned by various nations have to survive close encounters and where traffic density is much higher than in outer space:

In international road traffic, shipping and air traffic international standards and procedures have been adopted to minimize pollution of the environment and to maintain a reasonable degree

of safety, e.g., exhaust limits for cars, or rules prohibiting discharge of oil from vessels, or rules limiting noise pollution by airplanes near airports, or rules on littering which exist everywhere except in outer space. Safety of traffic is maintained by measures, such as traffic separation on highways or in sea lanes or in airplane corridors. Inactive vehicles on the road and at sea are subject to certain rules to prevent obstruction to active traffic. Briefly, international traffic is regulated by internationally agreed and adopted rules and standards.

Perhaps space traffic[6] should follow the good example of the first three environments and devise internationally agreed standards and procedures, let us call them "rules of the road" or "code of conduct". Such rules could be enforced on a national or international level, as the case may be.

Time is ripe for discussing these matters. In the UN we have a discussion of satellites with nuclear power sources which introduced regulatory principles such as a "sufficiently high orbit" which is another term for separation of traffic. Space debris, a non-item on the agenda at the UN COPUOS, are being discussed anyhow, because of their implications for environmental pollution and for safety of space operations. Time is ripe for demystifying outer space and for treating it as just another environment of the Earth. There is no need for waiting until things get worse. They will.

References:

1 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon an Other Celestial Objects. Jan.27, 1967, 18 U.S.T. 2410, T.I.A.S. 6347, 610 U.N.T.S. 205 (effective Oct. 10, 1967).

2 Gillieron, P., Un exemple d'evenement spatial: La Tour Eiffel de l'espace. Frontiers and Space Conquest, p. 183. Ed. J. Schneider and M. Leger-Orine, Kluwer, Dordrecht, 1988.

3 Cemetery in Space. Orbital Debris Monitor, Vol. 5, p.37, 1992.

4 Ehricke, Krafft A., Space light: space industrial enhancement of the solar option. Acta Astronaut. Vol. 6, pp 1515-1633, 1979.

5 Satellite Power Systems Concept Development and Evaluation Program, US Dept. of Energy, DOE/ER-0085, November 1980.

6 Perek, L., Traffic Rules for Outer Space. Proc. 25th Coll. on the Law of Outer Space, AIAA, p.37, 1983.