

# Moon Exploration: Legal Aspects

**Sergey Krichevsky**

Doctor of Philosophical Sciences, Professor, Chief Researcher, S.I. Vavilov Institute  
or the History of Science and Technology of the RAS  
(Moscow, Russia)

E-mail: [svkrich@mail.ru](mailto:svkrich@mail.ru)  
<https://orcid.org/0000-0002-1094-7770>

**Alexander Bagrov**

Doctor of Physical and Mathematical Sciences, Leading Researcher,  
Institute of Astronomy of the RAS (Moscow, Russia)

E-mail: [abagrov@inasan.ru](mailto:abagrov@inasan.ru)  
<https://orcid.org/0000-0003-0348-4971>

*Legal aspects of the theory and practice of Moon exploration are investigated through the problem statement in philosophical and legal discourse with the reflection of history, current condition and prospects, including the issue of its total colonization. Materials and results of initial research were published in 2018-2019. Main concepts and definitions are given. Main legal aspects of Moon exploration are highlighted and briefly reviewed: 1) human rights; 2) licensing; 3) intellectual property protection; 4) natural resource extraction and usage; 5) environmental protection; 6) new technologies, technical activities regulation and safety; 7) natural and cultural heritage preservation. Main conclusions and recommendations are formulated.*

*Keywords: Moon exploration and colonization, space activities, space law, licensing, intellectual property, environment, human rights, natural and cultural heritage, natural resources, technology*

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## Introduction

In the problem statement in philosophic-legal discourse, we will briefly consider the main legal aspects of the theory and practice of Moon exploration with the reflection of history, current condition and prospects, including to the point of its total colonization. Materials and

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results of initiative researches were published in 2018-2019<sup>1</sup>. Main concepts and definitions were given. The following main legal aspects of Moon exploration were allocated: human rights; licensing; intellectual property protection; natural resource extraction and usage; environmental protection; new technologies, technical activity regulation and safety; natural and cultural heritage preservation.

That is why in 2019 the subject of Moon exploration became essential due to: 1) anniversary dates — achievements in the history of Moon exploration. 60 years since first flights of automatic stations to the Moon. “Moon-1” flew at the distance of ~ 6000 km away from it, “Moon-2” reached the surface, “Moon-3” took and transmitted first pictures of the far side of Moon (1959, USSR). 50 years since first human Moon landing and first human step on it (Neil Armstrong, 1969, Apollo-11, USA); 2) new projects and results of flights to the Moon (China, Israel, India, etc.), USA plans to provide mankind attendance of the Moon by 2024, project of moon program development in Russia [Krichevsky, 2019b; Mirovaya pilotruemaya kosmonavtika, 2005; NASA; ROSKOSMOS].

Experience, problems and perspectives of evolution in theory and practice of Moon exploration and familiarization lead us to comprehension of necessity of urgent liquidation of existing lag in space activity regulation on national and international levels and crucial importance of forward-looking development of space law and new society institutions.

All this correspond to the efforts of world society under United Nations auspices, aimed at stable development of space activity which found their reflection in two new and important UN Conventions on space law and policy which were organized by space Committee — UNOOSA (2018, Moscow, Russia and 2019, Istanbul, Turkey) [United Nations Office for Outer Space Affairs]. This is necessary but not sufficient.

In international space law and space policy there are complex contradictions between the states and other participants concerning choice of model, vector, space exploration rates and technologies, extraterrestrial resources usage taking into account interests, potential of process participants, experience, internal and external constraints and other factors (see: [Volynskaya, 2018; Yeshchuk & Vasina, 2019]).

For efficient response to complex global challenges in rapidly changing environment, usage of space activity potential and new technologies for exploration of space and its resources in order to promote well-balanced stable development world society will have to move from the paradigm of parted and conflicting mankind to a new paradigm of unified mankind including the formation of the World space union [Krichevsky, 2019a].

It is necessary to create a new conception and model of space law for Moon exploration that will reflect the realities and perspectives of space exploration by world society in the upcoming new third period of Space era including the earlier proposed superglobal project of

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<sup>1</sup> Authors have considerable experience of scientific researches, development and realization of projects in the sphere of space activity, a number of publications. Sergei Krichevsky is a professional military pilot and test-cosmonaut who was a member of USSR and Russia cosmonaut squad in 1989-1998, in 1992 he took part as an expert of Supreme Council of Russia in the development of law project “About space activity”, since 1998 he has studied history of aerospace engineering and activity. [Mirovaya pilotruemaya kosmonavtika, 2005: 603; Zakon, 1993; Vlasov & Krichevsky, 1999; Krichevsky, 2012, 2018, 2019a, 2019b; Krichevsky & Udartsev, 2019]. Alexandr Bagrov is an astronomer and developer of tools for space explorations, in 1994-2014 he carried out researches on preparation of space experiment “Oziris”, since 2014 he has taken an active part in preparation of Russian lunar missions [Patent, 2012; Sysyoev et al., 2017; Bagrov & Leonov, 2015; Bagrov, 2019a, 2019b].

complete Moon exploration by mankind according to the well-balanced (“deductive”) scenario of creation of cosmic humanity in the long run [Krichevsky, 2018, 2019a, 2019b].

It is essential as Moon exploration is forefront and ground for all space activity with the aim of mankind survival and development on Earth and beyond Earth with the usage of extraterrestrial resource and principally new technologies which are to be created for this purpose taking into account the fact that new ideas, examples and samples already exist.

New second world moon race which started and is developing in the 21<sup>st</sup> century, aimed at Moon exploration, put forward difficult law questions to mankind. At present this exploration has not begun yet, but perspectives of extraterrestrial resources usage and attractive closeness of Moon to Earth already cause rivalry for them between space states. For almost over 40 years since the race between the USA and the USSR as for the primacy in man landing on Moon (since 1970s) there has not been observed serious activity in moon explorations. Today many people express bewilderment in this regard. But this pause is quite explicable. Even first Moon explorations with the help of spacecrafts let us get the answers to the most vital scientific questions, and further researches could only specify a bit the obtained answers as for nature of Moon as celestial body. But these “specifications” would have to be paid a high price of space missions.

The situation has started to change recently. We are already interested not only in scientific knowledge about Moon but more in applied information that will enable us to move to exploration of its resources. New research tasks are dictated by applied problems of the upcoming Moon exploration. These tasks are connected with different views on the character of human activity in Moon conditions — from usual for terrestrial methods usage of human labor in resource extraction to implementation of machines, robots for all kinds of work.

When the USSR first delivered its pennants to the Moon (14 September 1959, automatic station “Moon-2”) it only set its priority in reaching the first extraterrestrial space body. When astronauts Neil Armstrong and Buzz Aldrin stepped on the Moon surface and installed the US flag (21 July 1969, lunar module of the ship “Apollo-11”), they only built upon the primacy of the USA in landing of mankind on Moon from the planet Earth [Mirovaya pilotiruemaya kosmonavtika, 2005; NASA; ROSKOSMOS]. Neither in the first nor in the second case were these actions viewed as requisition for establishment of sovereignty over Moon. By this time international space Treaty was valid [Treaty, 1967] and it forbade establishment of sovereignty. But there did not arise the question as to which Moon resources can be used in practical life, and high cost of lunar missions put into doubt their feasibility in the nearest future for commercial usage.

Now when hopes for commercialization of Moon resources appeared, there appeared the necessity for development of technologies for their mining. Suchlike working-outs will cost much more than flag demonstration at extraterrestrial territory. Those who invest enormous financial resources into these working-outs are to be sure of their efficiency. A new phase of space race can provide its winner with vital superiority in getting the most obtainable Moon resources and even lead to suppressing of probable rivals. On the one hand, such actions will be viewed as a worthy result of serious investment into researches, but on the other hand, as violating rights of people who are not able to invest big money in suchlike working-outs.

The unfolding race for investigation and Moon resource development nourishes not only on hopes for future dividends but also on absence of international laws which would be able to regulate sharing of “space pie”. When there are no laws the “rule of the most powerful”, which is the most advanced contestant of the race, decides everything. No matter whatever the

leaders of space states would say, they all, apparently, hope that they will outrun their rival on their own and then face them with the fact of their superiority.

Sooner or later the rules of space resources usage must be created. Otherwise the results of costly usage will be litigated and the disputes arisen can lead to serious international conflicts. Everybody understands it and work at space legislation has been conducted for many decades [Halunko, 2019]. But at present slow space law, policy and diplomacy give benefit to those who hope in case of their superiority support it by relevant laws.

The developers of space law can be understood. Laws either reflect principles of long-standing relationships between people and states or are formed on the analogy of them for foreseen situations. In space long-standing rules of behavior (launching registry, astronauts rescue, responsibility for damage from spacecrafts, etc.) are fixed in the Treaty of space activity and a series of supplementary conventions. New space legislation must regulate the activity specific nature of which is unknown to legislators. Who or what will explore space resource and Moon resources in particular. Machines, robots, “avatars”? Cosmonauts? Whom will the mined resources belong to? To machine owners, operators of distantly controlled devices or cosmonauts? Or to some commercial structures which created machines or hire cosmonauts? And who and in what way must be responsible for negative aspects and consequences of space activity?

Actually future space legislation should be based on real predictions of character and scope of work in space. No space agency can formulate them yet. Even announced plans can change several times a year! Vaguely formulated aims (“gain a foothold on Moon”, “main target is Mars”, etc.) cannot be accepted as predictions. Moreover, some intentions should be viewed as utopian. “Traditional” economically ineffective and ecologically “dirty” rocket techniques which initiated space exploration cannot be basis for its large-scale exploration. Heavy and powerful rockets will be surely in demand at the process of creation of initial infrastructure of space settlements on Moon but only until alternative means of cargo transportation to Moon appear which in addition will provide great cargo traffic. And only principally new transport and other technologies and mechanisms will be able to make space exploration real, safe, environmentally friendly, economically possible and efficient.

It turns out that it is impossible to create universal space legislation at present. But it is possible and necessary to formulate and accept new rules of space activity which will spread around space, Moon and further in Solar system mutual understanding and practice of dignified and fair relationships of cooperation between people and countries which have been built over centuries of mankind evolution on Earth.

The situation is interesting, difficult and contradictory. Moon is ideal object for exploration “from scratch”: almost untouched surface and environment without biosphere, territorial, political and economic boundaries. But people have not agreed yet on how to explore Moon, although the process of exploration is getting started already. For successful and effective exploration it is necessary to have new rules, common strategy, significant funds and new technologies, uniting and distribution of world society efforts, cooperation of space and other states in balance with essential problem solving on Earth (by [Krichevsky, 2019b]).

## **1. Basic concepts and definitions**

*Moon exploration* — goal-oriented process of human activity on exploration of Moon embracing study, research and usage of Moon, all attributes of it, of its surface, subsoil,

resources with the aim of survival and development of man and society on Earth and out of Earth, on Moon, including to the point of total exploration and total colonization of Moon.

*Legal aspects of Moon exploration* — aspects of space law covering the whole complex of relationships connected with Moon exploration.

*Human rights at Moon exploration* — main human rights covering all relationships connected with Moon exploration.

*Technologies and equipment for Moon exploration* — technologies and equipment developed, created and used for Moon exploration at full life cycle.

*Licensing of space activity for Moon exploration* — system of rules defining permits and limits of activity in Moon exploration.

*Intellectual property protection* — legal protection of intellectual activity results in space which come in the form of inventions, useful models, industrial samples, etc.

*Environmental protection of Moon and circumlunar space* — complex of knowledge, “rules of the game”, measures and technologies aimed at preserving this environment.

*Natural and cultural heritage preservation at Moon exploration* — complex of knowledge, “rules of the game”, measures and technologies aimed at preserving the natural and cultural heritage of mankind on Moon including delivery of security objects (or their copies) from Earth and their preservation on Moon.

## **2. Short history, condition, problems and perspectives of space law for Moon exploration**

In the world there are in function international agreements and treaties which regulate the activity in space. Every sovereign state surely has its own internal legislation, but it should be coordinated at the level of international affairs with international laws, the coordinator of which is UNO.

The formation of space legislation is being carried out under United Nations auspices. Ten years after the launching into space of the first satellite “Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including Moon and Other Celestial Bodies” was signed and ratified by all space states [Treaty, 1967], and most countries of the world joined later. Its urgent development and adoption were caused by amazing success of world (first of all soviet) cosmonautics and fears of states concerning the fact that soon space will be divided between space states. Worst of all, in space can appear some weapon against which no state would have means of protection.

Treaty concerning space of 1967 was the first document which contents was precursive to space legal provisions. It simply declared the freedom of any researches in space and strictly forbade militarization of space. Actually only these main principles of space activity were fixed in the treaty, but neither methods of control of their fulfillment nor system of sanctions for their violation were determined. Though the Treaty claimed that “*Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means*” (Article II), this declaration was contradictory to Article VIII of the same Treaty. It says that “*A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer*

*space or on a celestial body...*” It can be understood thus: legislation of the owner state is considered valid on the constructed on Moon station with all its buildings, which will exist for millions or billions of years meaning that its sovereignty spreads forever on the whole construction area.

Race for superiority between the USSR and the USA stimulated preparation on the initiative of UNO in 1979 of “Agreement Governing the Activities of States on Moon and Other Celestial Bodies” [Agreement, 1979], in which principles of scientific and economic activity on Moon were discussed in detail. For instance, Article 8.1 of the Agreement declares that “*States Parties may pursue their activities in the exploration and use of moon anywhere on or below its surface...*”

This statement is loophole for those who want “according to the right of superiority” to conquer the prime territories of Moon. There are places on Moon which are of particular interest for placing first long-term stations on them. They include some mountain peaks in circumpolar Moon areas which are practically never shaded and where it is very profitable to put power plants of solar batteries. Of utmost interest are the places of location of “lava tubes” — natural holes under Moon surface where there can be located habitable stations, bases, settlements with guarantee of their protection against space radiation. Unlimited right of the states to locate their stations wherever they want gives preferences to superior space states and automatically infringes rights of those who will reach Moon later.

One more loophole represents Article 9.1 of the Agreement which runs that “*States Parties may establish manned and unmanned stations on the moon. A State Party establishing a station shall use only that area which is required for the needs of the station and shall immediately inform the Secretary-General of the United Nations of the location and purposes of that station...*” While developing “compact” territories the size of developed area will be defined by the developing organization itself, and Agreement makes its claims undisputable. Thus declarative nature as for usage of extraterrestrial territories can also cause conflict situations. Indeed, you can announce about your intention to carry out some works on a certain piece of land and then postpone their realization for years under different circumstances. Or other state will start works on this land without waiting for claimant’s fulfillment of his intentions and will inform UNO of beginning of works. Concerning the statements of Agreement we can see ambiguity of rights of these states as for this disputable piece of land.

But one thing is research of Moon and completely other one is its exploration, use, colonization. State, space agency or commercial organization during the process of space resources development will be interested in the property right for results of its work, income from invested money into development. Instead of this Article 11.3 declares that “*Neither the surface nor the subsurface of the moon, nor any part of natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person*”. It is obvious that compiled 40 years ago Agreement, which was aimed at assist in Moon exploration by space facilities, today is an obstacle for Moon exploration and its resources development.

It is surely a pity that qualified lawyers and legislators who worked out “Agreement Governing the Activities of States on Moon and Other Celestial Bodies” (1979) allowed so much ambiguity in the text of international document. Imperfection of Agreement led to the situation that neither state, member of UN Security Council, nor any of leading space states signed or ratified it. Although legally Agreement came into force, its validity is no way obligatory for states which did not ratify it.



Long pause in Moon exploration, which reflected absence of interest of space states in its development, did not promote development of space laws concerning space resources usage. So nowadays, 60 years after the beginning of Moon exploration by spacecrafts, legislation concerning Moon lags behind practice. Actually Moon got into the state of defenseless victim of any colonial intentions of predators willing for profit. Well-known statement of Roman law “All that is not prohibited is allowed” with absence of any bans frees hands for everybody who is in rush to take part in race for moon resources. Later, when (and if!) space law will be developed, other statement of Roman law will come into force: “One who owns let owns!” Thus, everything obtained before coming of law into force, no matter by what means and in what way it was obtained, will be admitted as its owner’s property. Thus slogan that “*exploration and usage of outer space including Moon and other celestial bodies is carried out in favor and according to interests of all countries, not depending on level of their economic or scientific development, and are property of all human beings*” will turn out as a blank declaration in reality.

Absence of clear legislation as for Moon and its resources is actually the factor which encourages large states to capture all space resources which they can reach. Taking advantage of absence of international laws some countries try to spread their national laws all over the space. In 2015 US President signed the bill HR 2262, according to which US residents are allowed to own all resources obtained by them in space. This law guarantees that obtained resources cannot be confiscated from their owners [H.R.2262, 2015]. Mass media announced that Luxemburg government adopted legislation norms as for mining on asteroids which allows any earthman mine and own space resources without any restrictions [Loi du 20 juillet, 2017].

There is an impression that imperfection of “Agreement Governing the Activities of States on Moon and Other Celestial Bodies” (1979) was caused by superficial ideas of lawyers preparing it of space settlements and specificity of space resources development. This is clearly seen in the article 11.5 of Agreement according to which “*States Parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible*”. Today this “when” has come and we will try to formulate those conceptual statements which must be reflected in space legislation.

### **3. Main legal aspects of Moon exploration**

#### **3.1. Human rights**

Aspect of human rights is viewed by us as first and prioritized as it refers to all people on Earth, especially to those who developed, develops and will develop Moon personally and directly beyond Earth, in outer space, in lunar space and on Moon itself. Existing main human rights are written for Earth, they do not reflect peculiarities of relationships connected with space exploration, including Moon exploration. In such a setting space activity, space law and human rights were studied by one of the article authors in 1993-2012 (see: [Krichevsky, 2012: 222-230]). Problem of human rights in space is not solved yet, is actual and its complexity is growing.

Let us formulate new human rights in connection with Moon exploration in the form of a number of certain positions as supplements and clarifications to the existing main human rights:

1. Right to participate in Moon exploration.
2. Right for obtaining and usage of results of Moon exploration, including right for material and intellectual property created, obtained as a result of space activity.
3. Right for moving from Earth to Moon, staying on Moon, permanent life on Moon.
4. Right for provision of safety and life activity during Moon exploration, staying on Moon and also for provision of social rights and guarantees on Moon and Earth.
5. Right for obtaining terrestrial citizenship (citizenship of states of Earth) for people born on Moon or any other extraterrestrial object.
6. Right for returning from Moon to Earth, moving from Moon to other celestial bodies, objects in outer space and backwards and also right for voluntary non-returning from Moon, from space to Earth.

There are complicated medical and bioethical matters connected with health condition, influence of adverse factors of space flights, environment beyond Earth, on Moon, with consideration of individual genetic and other peculiarities, including long-term consequences for a certain person and his descendants, human reproduction on Moon, after returning on Earth etc.

Great difficulty bear matters of new technologies implementation, interaction between mankind and robots, creation of biological and cybernetic copies, biocybernetic systems, avatars and others, distant and combined control online, with usage of virtual reality and artificial intellect, usage of systems of artificial gravity, radiation defense, lunar dust and other dangerous factors of activity and environment.

New human rights connected with Moon exploration must be formulated and declared on behalf of UNO, and must be deliberately realized.

### **3.2. Licensing**

Resolution of UN General Assembly № 68/74 from 11 December 2013 “Recommendations on national legislation relevant to the peaceful exploration and use of outer space” calls for the states to consider in their laws about national space activity the following: “...3. *Space activities should require authorization by a competent national authority...*” and “4. *The conditions for authorization should be consistent international obligations of States, in particular under the United Nations treaties on outer space, and with other relevant instruments...*” [Resolution, 2013]. These recommendations actually transfer control over economic activity under the jurisdiction of states. Legislation of various states as for space can differ from each other, and this easing can lead to ambiguous formulation of rules of space activity fulfillment. But the thing that worries most of all is that Resolution gives the states the right to set boundaries of extraterrestrial territories which they claim on.

We propose to use the principles of setting of territorial boundaries of appliance of national laws, according to which national sovereignty spreads only up to the height of 100 km over the state territory above which the outer space starts. National legislation cannot be spread onto it according to the valid Agreement of 1967.

It will be reasonable if all outer space is completely transferred under the jurisdiction of International space legislation. In such a case, supranational Committee, operating on behalf of UNO by its mandate, will act as a competent agency giving the right for space activity. Committee can give licenses for space activity to state, interstate and private individuals or organizations on introduction of the state which positions itself as guarantor of future licensee.



One of the kinds of licensing must be issuance of permits for developed territories on celestial bodies, including on Moon<sup>2</sup>. Such licenses must be given for a limited time, in addition, the licensee can be early withdrawn if licensee carries out his works with violation of license conditions. The license conditions must include period of its validity, discussing reasonable time before starting of works and maximum term of license validity after suspension (stopping) of works. Suchlike principle of licensing will help to avoid blank declarations about intentions which are not supported by real plans of realization of works on outer space territory, and avoid holding of one-time events in space aiming at “staking” its presence on licensed territory.

Obligatory constituent of license conditions must be limited territory on which it is permitted to fulfill space activity. Size of this territory must correspond to the set task of space activity. For instance, a plot of land 20 miles in diameter can be allocated for construction of permanent base or settlement. The peculiarity of construction on Moon is that the settlement will be in the form of a single multistoried building the height of which will differ only a bit from its horizontal sizes. In a settlement with size of 10x10 km with height of 1000 stories the square of inhabited accommodation will be 100 billion m<sup>2</sup>, which is enough for living of 100 million population and everyone will have 1000 m<sup>2</sup> of buildings of for various purposes. That is why the licensed for construction territory of the proposed size will be enough for hundreds of years of active usage. 45000 plots of land of such size on Moon can be allocated and 4500 billion people can comfortably live on them [Bagrov, 2019b].

The question of territorial *property* of “any state, international intergovernmental or nongovernmental organization, national organization or nongovernmental institution or any individual” on Moon is withdrawn if the territory is *given* to licensee not as property, but for temporary usage.

Connected with it the question of “national appropriation by proclamation of sovereignty” during licensing of near-Earth territories on behalf of UNO is gaining different sense. Implementation of scientific and business activities on licensed territory cannot be done behind legal scope. It is clear that jurisdiction on this territory must be given licensee guarantor, to the state under which flag space activity will be fulfilled on the licensed territory. In this case national legislation will take into account interests and traditions of those people who will fulfill licensed activity. Sovereignty of state-guarantor of licensee in connection with implementation of its internal legislation on the given territory is natural basis for state responsibility for realization of license conditions.

The role of states in the development of space resources remains decisive in the regulation of space activities even after the involvement of private corporations. In the future, it will probably only increase (by [Krichevsky & Udartsev, 2019]). Therefore, future space legislation should be based on its support by state structures.

Question of natural resources of licensed territory, including its subsoil, must be clarified better than it was in Article 11.3 of Moon Agreement. There are no places on Moon where mining of mineral resources or conditions of construction of inhabited buildings could have exclusive advantages in comparison with other territories. That is why thesis that territory development “... does not create property right on Moon surface or subsurface or their areas”

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<sup>2</sup> Alexandr Bagrov proposed novation: “licensing of territories” (by [Bagrov, 2019b]), which can be implemented for regulation of process of Moon exploration. The analogy is regulation of usage of positions of geostationary orbit in near-Earth space at the distance of ~36 000 km from Earth, when International telecommunication union (ITU), which fulfills distribution of global radio spectrum and satellite orbits, actually gives permits — international licenses on usage of local areas of outer space for telecommunication, liaison apparatus (communication satellites and others). See: [ITU].

(Article 11.3 of Agreement [Agreement, 1979]) is contradictory to Article 1 of Treaty of 1967, according to which “*The exploration and use of outer space, including Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind*” [Treaty, 1967]. How can mankind heritage be really used if people have no right to appropriate it which means to use? It is sensible to draw an analogy with world ocean resources, which are obtained by ship owners or by states which have the right for adjoining their coastal boundary shelf. Obtained seafood and mineral resources are considered as absolute property of getters and can be used both for inner use and for sale. It is necessary to admit property right of licensee for all obtained on the licensed territory resources.

### **Obligatory conditions for obtaining license for extraterrestrial territories**

As a matter of principle, some (justified!) restrictions for mining and usage of space resources can be introduced. For instance, condition of *total processing, utilization* of associated waste must become absolute restriction on mining of mineral resources.

On Moon natural conditions and mechanisms of degradation of human waste are principally different in comparison with those on Earth. Thrown away broken mechanism will lie on Moon for millions of years in the same state. During the time of intense activity on licensed territory there can appear too much waste and it is completely unacceptable to create garbage dumps and waste piles from mineral resources mining. License for space activity must point out absolute inadmissibility of waste piling. On Earth we have already faced ecological consequences of waste piling with which natural recreational mechanisms do not cope. And on Moon, where there are no such mechanisms at all, problem of waste utilization must be solved with the first steps of its development. Problem of human waste utilization is partly solved on inhabited space stations; this experience must be used on Moon, too. Different kinds of mineral waste can be used for lunar construction works. This implies simple and clear rule: you can mine as many resources as you can utilize waste from mining.

We would like to point out one more element of space activity which is not viewed yet in space legislation. Exceptional stability of lunar constructions from local solid basalt lets create on Moon extremely reliable storage of cultural values of mankind [Pavlov & Bagrov, 2018]. That is why space legislation must form the system of preferences for licensees which will give part of their buildings for museum needs.

It turns out that work on space legislation must cover all sides of multifaceted human activity on Moon. Some legislation norms can be postponed to better times, but kernel of space laws — regulatory provisions as for principles of space resources mining and usage — is a matter of some urgency.

We propose to give corresponding status to United Nations Office for Outer Space Affairs (UNOOSA), which will exclusively regulate all kinds of space activity. Stressing on the unique position of Moon as the most perspective object of colonization, we find it necessary to foresee within the framework of Committee work of special unit, which management will include licensing of territories for construction of lunar stations and settlements and duty of control of work conformity on licensed territories to license conditions, and withdrawal of license in case of violation of license conditions. Territory licensing is proposed to carry out according to conceptions of states representing guarantors of licensees and accept jurisdiction of states-guarantors on licensed territories.

### **3.3. Intellectual property protection**

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Finally, there is one more space open to pirates. This is the sphere of intellectual property. Space is the area of implementation of the highest technologies saturated by the results of intellectual activity. Surprisingly, but in outer space no invention is defended by patent right. Patent legislation still exists only in the realm of national jurisdiction of states which does not extend to space. Most perspective working-outs, most profitable inventions can be exploited completely legally in space without any commitment to inventors and patent owners [Bagrov, 2019a]. It is necessary to form such international legislation system in which intellectual rights of space technologies developers will be guarded in the whole outer space and during the whole period while they are in demand.

It is important to provide protection of inventions used in space starting from period of priority publication to the whole period of their usage without any limit for protection deadline. Nowadays patent right is based on 20-year term of invention protection, whereas peculiarities of space technology lead to the fact that first (!) invention usage can take place only decades later after filing a patent application.

### **3.4. Mining and usage of natural resources**

Space exploration, and Moon exploration in particular, only at initial period will rely on earth resources. Actually, planet Earth consists of the same mineral composites as other bodies of Solar system. The most attractive resource of Moon is stability of conditions on it and possibility of creation on Moon inhabited objects, invulnerable to natural disasters. This is the resource lack of which on Earth causes serious worries about stable development of our civilization and even about its existence at global climate changes and other global catastrophes. Any constructions on Moon from monolithic lunar basalt will stay without repairment millions of years which will really reduce cost of capital construction by hundreds and thousands times in comparison with construction on Earth. That is why possibility of creation on Moon safety conditions for relocation of people in response to natural threats is a powerful stimulus for Moon exploration. Undoubtedly, development of territorial Moon resources to the full extent will correspond to main principle Article 1 of Treaty of 1967 which states that “*The exploration and use of outer space... shall be the province of all mankind*” [Treaty, 1967].

Metal oxides are integral part of lunar basalts (up to half of weight), that is why on Moon at any place you can mine oxygen, iron, titanium, rare earth metals and other metals. Hardly the needs of earth industries will be covered by these resources but they will provide the conditions for independent development of lunar settlements.

### **3.5. Environmental protection**

As a result of peculiarities of space activity and used technologies environmental protection concerning Moon exploration covers: Earth, near-Earth space, near-Moon space and Moon [Krichevsky, 2012, 2019b; Vlasov & Krichevsky, 1999].

We have noted earlier categorical inadmissibility of waste storage on Moon. Ways for reaching non-waste colonization of Moon are even now clearly seen. Those solar ovens on the basis of which building 3-D printers will work [Sysoev et al., 2017], can effectively utilize any kind of waste. For instance, waste from recycling of mineral raw materials can be used as material for monolithic construction, and any organic waste, which cannot be used repeatedly, can be volatilized in these ovens, which at volatilization temperature will have speed higher than speed of runaway not only from Moon, but even from Solar system. Thus provision of 100% waste utilization on Moon must not have any technical complications

and right of complete environmental protection in space settlements must be fixed in space legislation.

As elevator transport systems will be one of the key elements of space development technologies, their usage will have a great significance for environmental protection on Earth. The fact is that payload, taken out of Earth, will be transported by elevator system at space speed [Bagrov et al., 2012]. It is possible to find such moment of location of Earth, Moon and Sun when accelerated to speed of Earth orbital movement capsule, undocked from elevator system, will fall onto Sun under the influence of solar gravity. This will make it possible to realize the program of dropping of stored on Earth containers with radioactive and other toxic waste onto Sun. They all will burn out in solar atmosphere without any consequences for it and there will be no threat of environmental pollution by dangerous waste on Earth. Space legislation must surely discuss the necessity of dangerous waste treatment of Earth at the process of Moon exploration (according to Alexander Bagrov, 2019).

For protection of unique objects of natural heritage as untouched wild nature (see p. 3.7), space nature reserves must be created on specially allocated Moon territories — on the analogy with Earth. One of the authors of the article proposed project “Space nature reserves” on Moon: zoning of Moon surface and near-Moon space with allocation in environment the territories of space wild nature protection with limit mode or full ban of technical activity and nature usage aiming at preservation of objects of natural and cultural heritage including monuments to nature and technology on Moon (first publications were in 2003-2012 [Krichevsky, 2012: 202-215, 378-381], also see: [Krichevsky, 2019b: 23]).

Aspect of environmental protection is connected with new technologies, technical regulation and technical activity safety and also with preservation of natural and cultural heritage (see further in p. 3.6 and p. 3.7).

### **3.6. New technologies, technical regulation and technical activity safety**

It is necessary and obligatory to adapt existing on Earth national and international systems of technical regulation and technical safety, to develop them for safe and effective development of Moon at full life cycle of technical activity.

The priority is minimization of consumption of natural resources, risks and negative effects and consequences for a person, society and environment.

It is possible only at transition to the best available technologies and principally new eco-friendly, clean and green technologies. [Krichevsky, 2012; 2018, 2019b; Soroka & Syntichenko, 2018].

One of the authors of the article investigates the evolution of Moon exploration technologies including looking into specific examples of environmentally friendly technologies and projects developed in the world in 20<sup>th</sup>-21<sup>st</sup> centuries. Environmentally friendly technologies and projects are those which correspond to ecological norms or outpace them, do not have negative influence on the environment, life and health of people or which have less negative influence in comparison with others. Classification of environmentally friendly, clean technologies and projects of Moon exploration, taking into account their special purpose, covers the whole spectrum of space activity and includes the following main parts: 1) exploration of Moon and other objects; 2) transport; 3) creation of infrastructure on Moon; 4) energy (including for Earth and Moon); 5) life support and human security; 6) mining, processing and usage of natural resources; 7) environmental protection and restoration; 8) preservation of natural and cultural heritage (according to: [Krichevsky, 2019b]).

Legal regulation must be directed at stimulation of transition to environmentally friendly, clean technologies, their wide usage and also at implementation of strict limits as for usage in space, on Moon of technologies which create excessive risks for people and infrastructure and environment pollution.

### **3.7. Preservation of natural and cultural heritage**

Preservation of natural and cultural heritage on Moon is necessary and possible on the basis of legal acts of world society under the auspices of UNO, appropriate international conventions and organizations, activity of UNESCO and United Nations Environment Programme. Their supplement and adaptation with account of conditions and peculiarities of space activity, connected with Moon exploration and research, are necessary [Krichevsky, 2012, 2019b; UNESCO; United Nations].

It is proposed to initiate and in collaboration with UNESCO create and supplement World lists of natural and cultural heritage on Moon, and for this there are already unique and valuable real objects. They are unique natural objects and landscapes of Moon (craters, mountains, etc.); objects of technical culture of mankind (machinery and activity traces: lunar ship modules Apollo, USA; spacecrafts “Lunohod-1”, “Lunohod-2”, USSR, etc.) They need protection among other things due to the starting process of Moon exploration.

High firmness and invulnerability of lunar constructions from effects of disasters let us view them as an exceptional opportunity for storage of physical objects of world culture. Display cases and galleries for visitors can be separated in museum areas on Moon. Exhibits can be located in gas environment which excludes the possibility of survival of all kinds of harmful organisms in it, whereas visitors will stay in conditions of regular atmosphere. Character of lunar construction from monolithic basalt allows even during the process of construction of museum complexes to prototype in smallest details the architectural performance of any terrestrial masterpieces, for example, to create exact copies of halls of Winter Palace in St. Petersburg or St. Peter’s Cathedral in Rome. Copying of many historic buildings, located on Earth in earthquake and flood zones will allow preserving on Moon architecture samples for our descendants. [Pavlov & Bagrov, 2018].

It is necessary to discuss separately questions of preservation of elements of history of the colonization of space: launched on the Moon vehicles, the first lunar stations and settlements, elements of life and authentic items which were used by cosmonauts at the creation of habitable zones on the Moon, activity traces and others. The need to preserve evidence of human expansion into space, history of Moon exploration and development should be discussed in space legislation.

Almost unlimited opportunities of capital construction on Moon can ensure the construction of museum complexes on Moon, capable of accommodating originals or copies of all treasures of world culture — manuscripts, books, paintings, sculptures, architectural masterpieces, reconstructions of archaeological findings, samples of machines, etc. The unlimited growth of the area and volume of museum premises will create in future opportunities to completely refuse from the concept of museum reserves and to provide round-the-clock access for visitors to museum expositions. Humanity is really interested in the fact that accumulated treasures must not be lost because of natural disasters, wars or barbaric destruction on Earth.

At the same time, it can be emphasized that possibilities of lunar construction will allow creating premises of larger volume in which it will be possible to place landscape zones and

create reserves in them for preservation of samples of inhabited territories of Earth (their models and real objects). Moreover, in special landscape zones on Moon in future it will be possible to create and maintain conditions for preservation of rare and endangered species of terrestrial organisms, and even for inhabiting them with disappeared on Earth but recovered by scientific methods animals and plants, with the creation of artificial gravity and other environmental conditions similar to conditions on Earth.

Problems of conservation of objects of natural and cultural heritage of mankind on Moon must be duly reflected in outer space right.

## Conclusions

1. A brief analysis of the history, conditions, problems and prospects of main legal aspects of theory and practice of Moon exploration, including to the point of its total colonization, is made.
2. Lack of adequate laws, stimulating and regulating complex activity for Moon exploration, its resources, is a brake for sustainable development of space activity, mankind expansion into space.
3. In connection with the features, problems and prospects of the started in XXI century new world lunar race, aimed at the development of Moon, it is necessary to organize advanced integrated management of Moon exploration process under the auspices of UN, for which to initiate, work out, create:
  - 3.1. New “rules of the game”, including: additions to basic human rights, taking into account the peculiarities of Moon exploration and new status of people, including permanent life on Moon, having children, relationships with states on Earth, social rights and guarantees for them on Moon and Earth; new “Agreement the Activities for Moon exploration and colonization”, etc.;
  - 3.2. new institutions, structures of Moon exploration, including World space agency and Department of Moon;
  - 3.3. legislation about licensing, including permission issues as for the use of technologies, territories and resources;
  - 3.4. legislation on property during Moon exploration including during mining and usage of natural resources;
  - 3.5. legislation on new technologies, technical regulation and safety of technical activities for Moon exploration;
  - 3.6. legislation on the protection of Moon’s environment and near-Moon space.
4. It is proposed to initiate and in cooperation with UNESCO create and supplement lists of world natural and cultural heritage on Moon which need protection in connection with process of Moon exploration.
5. It is advisable to organize a systematic research of legal aspects of Moon exploration, including in the format of new International institute (center) of problems of Moon exploration and colonization, which is proposed to be created.

## References



- Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (United Nations, *Treaty Series*, vol. 1363, №. 23002). 1979.
- H.R.2262 — U.S. Commercial Space Launch Competitiveness Act, 2015. <https://www.congress.gov/bill/114th-congress/house-bill/2262>
- Bagrov, Alexander. Zashchita intellektual'noy sobstvennosti v kosmicheskom prostranstve. *Innovation and Expertise*. 2019a. Issue 1 (26) : 21-26. (in Russian).
- Bagrov, Alexander. How to share the Moon? *Aerospace Sphere Journal*. 2019b. No 3: 26-35. (in Russian). <https://doi.org/10.30981/2587-7992-2019-100-3-26-35>
- Bagrov, Alexander and Vladislav Leonov. Nereshennyye yuridicheskie problemy osvoyeniya kosmosa. *Proceedings of 53th scientific readings in memory of K.E. Tsiolkovsky*. Kaluga, “Eidos” Publ. house, 2015: 383-385 (in Russian).
- Halunko, Valentyn. Space Law: the Present and the Future. *Advanced Space Law*. Vol. 3, 2019: 30-47. <https://doi.org/10.29202/asl/2019/3/3>
- International Telecommunication Union (ITU). <https://www.itu.int/ru/action/Pages/default.aspx>
- Krichevsky, Sergey. Aerospace Activities: Interdisciplinary Analysis. Moscow: LIBROKOM, 2012. (In Russian).
- Krichevsky, Sergey. Super Global Projects and Environmentally Friendly Technologies Used in Space Exploration: Realities and Prospects of the Space Age. *Philosophy and Cosmology*, Vol. 20. 2018: 92-105. <https://doi.org/10.29202/phil-cosm/20/8>
- Krichevsky, Sergey. Cosmic Union of Communities: a New Concept and Technologies of Creating Cosmic Humanity. *Philosophy and Cosmology*, Vol. 22. 2019a : 33-50. <https://doi.org/10.29202/phil-cosm/22/4>
- Krichevsky, Sergey. The exploration of the Moon: history, model, superglobal project and environmentally friendly technologies. *Aerospace Sphere Journal*, 2019b. № 3: 16-25. (In Russian). <https://doi.org/10.30981/2587-7992-2019-100-3-16-25>
- Krichevsky, Sergey and Sergey Udartsev. Space State on Earth and Beyond: Philosophy, Models, Experience and Prospects. *Philosophy and Cosmology*, Vol. 23. 2019: 30-52. <https://doi.org/10.29202/phil-cosm/23/4>
- Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace. (Luxembourg), 2017. <http://legilux.public.lu/eli/etat/leg/loi/2017/07/20/a674/jo> (in French).
- Mirovaya pilotiruemaya kosmonavtika (Istoriya. Tehnika. Lyudi)*. Pod red. Yuriya Baturina. Moskva: RTSoft, 2005. (In Russian).
- NASA (USA). <https://www.nasa.gov/>
- Patent RU 121233: The transport system “Earth-Moon” (Bagrov Andrey, Bagrov Aleksandr, Leonov Vladislav), 2012. <https://patents.google.com/patent/RU121233U1/en>
- Pavlov, Alexander and Alexander Bagrov. Zadacha sokhraneniya istoricheskogo i kul'turnogo nasledia chelovechestva. *S.I. Vavilov Institute of the History of Science and Technology. Annual Scientific Conference*, 2018. Moscow, “Janus-K”, 2018 : 680-683. (in Russian).
- Resolution the General Assembly UN A/RES/68/74. Recommendations on national legislation relevant to the peaceful exploration and use of outer space, 11 December 2013.
- ROSKOSMOS. <https://www.roscosmos.ru/>
- Soroka, Larysa and Olena Syntichenko. Sustainable Development of “Green” Technologies: Legal Protection of the Ambient Air from Pollutants. *Advanced Space Law*, Vol. 2. 2018: 70-75. [doi.org/10.29202/asl/2018/2/9](https://doi.org/10.29202/asl/2018/2/9)
- Sysoev, Valentin, Alexander Bagrov, and Vladislav Leonov. Solar 3-D printer for lunar construction. *3rd International Conference and Exhibition on Satellite & Space*

- Missions*, May 11-13, 2017 Barcelona, Spain. *J Aeronaut Aerospace Eng*, 2017. 6:2 (Suppl).
- Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (United Nations, *Treaty Series*, Vol. 1363, № 23002), 1967.
- UNESCO. <https://en.unesco.org/>
- United Nations. <https://www.un.org/en/>
- United Nations Office for Outer Space Affairs. <http://www.unoosa.org/oosa/index.html>
- Vlasov, Mikhail and Sergey Krichevsky. *Ecological Threat of Space Activity. Analytical Review*. Moscow: Nauka, 1999. 240 p. (In Russian).
- Volynskaya, Olga. Mezhdunarodnye politiko-pravovye aspekty ispol'zovaniya kosmicheskikh resursov. *Zhurnal rossijskogo prava*, 2018. № 9 (261): 145-154. (In Russian). [https://doi.org/10.12737/art\\_2018\\_9\\_14](https://doi.org/10.12737/art_2018_9_14)
- Yeshchuk, Olga and Anna Vasina. Chinese Space Law: Problems and Areas of Reforming. *Advanced Space Law*. Vol. 3. 2019: 140-150. <https://doi.org/10.29202/asl/2019/3/12>
- Zakon RF ot 20 avgusta 1993 g. No 5663-I "O kosmicheskoy deyatel'nosti"* (In Russian).