ETHICAL ASPECTS AND PROSPECTS OF SPACE EXPLORATION AND EXPLOITATION

Tereshkova VV[1], Tereshkova EA[2], Firsov DE[3] ✉

[1] The State Duma of the Federal Assembly of the Russian Federation, Moscow, Russia

[2] TereshkovaVV. Charitable Foundation, Moscow, Russia

[3] Yaroslavl State Medical University, Yaroslavl, Russia

In the 21st century, the rapid advance of space programs raises ethical concerns about the consequences of exploring and exploiting space resources. The concept note of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) on the ethical considerations on space exploration and exploitation adopted in August 2024 states that "the international community is now in need of developing ethical principles for space exploration and exploitation that complement currently existing outer space treaties". Key areas for future ethical regulation of space projects include prospects for commercial developments, space tourism programs, mining, and deep space exploration to study exoplanet atmospheres and search for terrestrial planets. Space exploration provides important knowledge that improves the quality of life and has a technological and innovative impact on society. The "inspiring factor" of space research is crucial for motivating future generations of scientists to develop science. However, it must be borne in mind that human activities pose significant risks to both near-Earth space and Earth's ecosystems. The scale of space ethics proposed by COMEST will help systematize information about ethical uncertainty factors, risks and consequences of risks associated with initiatives in space exploration and exploitation.

Key words: space research, UNESCO, The World Commission on the Ethics of Scientific Knowledge and Technology, space ethics, ecology

Author contribution: all authors have made an equal contribution to the preparation of the material and the writing of the article.

✉ **Correspondence should be addressed:** Denis E. Firsov
Revolutsionnaya str., 5, Yaroslavl, 150000, Russia; f300670@mail.ru

Received: 24.09.2025 **Accepted:** 20.11.2025 **Published online:** 04.12.2025

DOI: 10.24075/medet.2025.024

ЭТИЧЕСКИЕ АСПЕКТЫ И ПЕРСПЕКТИВЫ ИЗУЧЕНИЯ И ОСВОЕНИЯ КОСМИЧЕСКОГО ПРОСТРАНСТВА

В. В. Терешкова[1], Е. А. Терешкова[2], Д. Е. Фирсов[3] ✉

[1] Государственная Дума Федерального собрания Российской Федерации, Москва, Россия

[2] Благотворительный фонд Терешковой, Москва, Россия

[3] Ярославский государственный медицинский университет, Ярославль, Россия

Темпы развития космических программ в XXI в. ставят перед исследователями вопросы этического характера, связанные с последствиями изучения и освоения ресурсов космоса. В принятой в августе 2024 г. Всемирной комиссией по этике научных знаний и технологий (КОМЕСТ (COMEST)) в концептуальной Записке «Об этических соображениях при исследовании и эксплуатации космоса» отмечается, что «международное сообщество в настоящее время нуждается в разработке этических принципов исследования и эксплуатации космического пространства, которые дополняют существующие в настоящее время договоры по космосу». Задачи этического регулирования космических проектов должны охватывать перспективы развития коммерческих разработок, программы космического туризма, добычу полезных ископаемых, исследования дальнего космоса, в том числе для изучения атмосфер планет вокруг других звезд и поиска планет земного типа. Изучение космической среды дает важные знания, улучшающие качество жизни, расширяет технологическое и инновационное влияние на социум. Важен и «вдохновляющий фактор» космических исследований, побуждающий новые поколения ученых заниматься развитием науки. При этом необходимо учитывать наличие рисков влияния деятельности человека на околоземное пространство и непосредственно на экосистему Земли. Предложенная КОМЕСТ шкала космической этики поможет систематизации информации об этических факторах неопределенности, рисков и последствий рисков, связанных с инициативами в исследовании и эксплуатации космоса.

Ключевые слова: космические исследования, ЮНЕСКО, Всемирная комиссия по этике научных знаний и технологий, космическая этика, экология

Вклад авторов: все авторы внесли равный вклад в подготовку материала и написание статьи.

✉ **Для корреспонденции:** Денис Евгеньевич Фирсов
ул. Революционная, д. 5, г. Ярославль, 150000, Россия; f300670@mail.ru

Статья поступила: 24.09.2025 **Статья принята к печати:** 20.11.2025 **Опубликована онлайн:** 04.12.2025

DOI: 10.24075/medet.2025.024

The first steps in 20th-century space exploration spurred bioethical questions about human expansion beyond biosphere. The Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies (Moscow-Washington-London, January 27, 1967) [1], Agreement on the rescue of astronauts, the return of astronauts and the return of objects launched into outer space (December 19, 1967) [2], Convention on international liability for damage caused by space objects (Moscow — London — Washington, March 29, 1972) [3], Convention on registration of objects launched into outer space (New York, January 14, 1975) [4] and a number of other international documents [5] were adopted.

In the 21st century, ethical issues of space exploration turned into necessary and urgent tasks of civilizational importance due to the intense progress of science and technology.

THE RELEVANCE AND TASKS OF FORMING SPACE ETHICS PRINCIPLES

When the world community recognized that it was necessary to develop ethical regulators for space programs, a decision was adopted on August 24, 2009 during the 182nd session of UNESCO that enlarged the powers of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), an advisory body and forum of reflection that was set up by UNESCO in 1998.

"To improve the ability of COMEST to advise UNESCO on ethics of science, nanotechnologies, and ecological ethics as expected, the structure of COMEST should be enhanced to be similar to other expert advisory bodies, like the International Bioethics Committee" [6].

The International Bioethics Committee (IBC) was established in 1993. It prepares documents to define priorities for international bioethical discussion. The International Bioethics Committee (IBC) is related to the Intergovernmental Bioethics Committee (IGBC) and the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST).

At the 13th (Ordinary) Session of COMEST in September 2023, the Working Group established by the Commission adopted the concept note of the World on the Ethical Considerations on Space Exploration and Exploitation in August 1, 2024 under the working program for 2024–2025 [7].

The ethical considerations related to space exploration and exploitation proposed by COMEST are based on previous Commission documents such as the Report on the Ethics of Space Policy (2000), the Report on the Ethics of Water Resources: Ocean, Freshwater, Coastal Areas (2018), the Report on the Ethics of Land Use (2021), and the Report about the Ethics of Climate Engineering (2023).

It is stated in the introduction to the concept note of COMEST 2024 that the humanity is entering a new era of space exploration and exploitation and plans to establish permanent robotic and human bases on the Moon, asteroids and Mars, conclude Lunar international treaties and allow the private sector to fully lead commercial space missions. Thus, "the international community is now in need of developing ethical principles for space exploration and exploitation that complement currently existing outer space treaties".

Stating that "humanity has benefited enormously from the exploration of space in the last 60 years" and that international cooperation is essential for space exploration, COMEST suggests that the following ethical issues have to be solved:

- the consequences of private, commercial and public efforts in space exploration and exploitation, in terms of responsibility to present and future generations;
- ethical concerns of the geopolitical implications of the "race for permanence in space" and equal access to space for all countries, including space governance, space militarization, space tourism, and potential environmental harm to space.

According to COMEST, space exploration has entered "a breakthrough era" owing to the development of space projects, space tourism, space mining and human permanent presence in space in 2025 to 2100. Active lunar exploration is planned as well. The Artemis Initiative (2010) led by the NASA that aims to land astronauts on the Moon is one example [8].

The international Mars exploration programs are found perspective as their goals include permanent missions and potential terraforming to ensure long-term human presence on Mars and protection from solar and cosmic radiation.

Astrophysical studies of far space are highly perspective. They include the ones using the James Webb Telescope (JWST) that opened the doors to distant worlds around other stars and made the search for Earth-like planets possible.

Developing ethical and sustainable space regulations must account for future technology associated with resource extraction and profit generation. This requires concluding contracts and creating a global legal infrastructure for sustainable ethical cooperation resulting in competition between the private and public sectors over the next decades that will likely fuel a self-sustaining space industry.

Defining the modern state of space ethical regulation, COMEST states that the existing international treaties and associated agreements deal with space exploration problems and risks. Some of these agreements may require revision to bring them up to date in this new era of space ethics. The question of environmental problems and the use of physical resources in space remains largely open. Efforts are being taken to solve the issue now. In particular, the UN Committee on the Peaceful Uses of Outer Space (COPUOS), established on December 12, 1959, works on international cooperation for space debris management.

Modern "space ethics" must correlate 20th-century principles of space explorations with contemporary advantages and risks.

According to COMEST, the advantages definitely include technological and scientific effect of space exploration on the life of a human including the use of numerous items in our everyday life.

Social achievements and benefits that improve daily life consist of enhanced satellite communications and telecommunications, global positioning, food and fisheries production, medical developments and achievements in weather forecasting and climate monitoring, management of forest, natural disasters, and pollution, as the data are vital for environmental conservation and efforts to mitigate the effects of climate change. Thus, space exploration provides people with essential knowledge and possibilities to be used by the society.

"Space exploration has also contributed to many diverse inventions used in everyday life, from solar panels to heart monitors, from cancer therapy to lightweight materials, rechargeable batteries, miniaturization of multiple devices and from water purification systems to improved computing systems, environmental studies and global search and rescue systems".

As stated in COMEST, the "inspiring factor" of space research is its power to inspire new generations of scientists to develop science, technology, mathematics and engineering, as well as offer unique and innovative solutions for numerous social problems.

Significant risks in human spaceflight include cosmic radiation, the physiological effects of weightlessness leading to muscle and bone loss and osteoporosis, hearing loss due to the constant exposure to the noise from orbital station equipment. The inability to prevent these negative consequences has led to the use of robotics in space exploration systems. In the future, maximum scientific and economic benefits are expected from the partnership between people and robots. In this regard, comparing the possible risks and benefits of human participation in extraterrestrial resource development is a key task of space ethics.

Environmental risk group should include the impact of human activities on near-Earth space and the Earth's ecosystem. Accumulation of space debris in Earth's orbit poses a significant risk to active spacecraft and creates a direct physical risk on Earth's surface due to uncontrolled descent of debris. Rocket launches can damage the atmosphere and the ozone layer. Ground-based facilities like spaceports influence local ecosystems.

The expansion of space missions in the future will increase risks to planetary environmental protection. The possible depletion of space resources as a result of their uncontrolled use is the major long-term ethical concern that should be recognized now to exterminate the dilemmas of advantages and risks of cost-effective space exploration.

The COMEST study stresses that key ethical aspects of space exploration and exploitation should be determined "since intuitive principles applicable on Earth may not be appropriate outside the planet".

According to COMEST, basic principles of space ethics include equative justice and fairness, nonmaleficence and beneficence and respect and the precautionary principle.

Justice and fairness are basic ethical principles in space exploration that should be open and inclusive for both individuals, and countries. The requirement primarily concerns distribution and re-distribution of space resources depending on the research potential of different countries.

The problem can be solved through a fairly balanced participation in space projects under due consideration of the interests of the countries without necessary resources for space exploration. The same goes for the educational resources used to exchange knowledge and build the capacity of the countries interested in space programs, including the interests of future generations.

Space research participants should be informed of possible risks and harm mitigation efforts. The principles of nonmaleficence and beneficence should be used in the context of multispecies ethics, while sending animals to space and as astrobiological principles to protect any possible habitats for life.

Balancing space exploration with preservation is crucial not to compromise the space environment for current and future use. International agreements should provide solutions to issues related to the use of space resources, including in terms of increased competition and risk of conflict.

Ecological ethics in space should rest upon the requirements to environmental protection, space preservation and restoration. Space activity can be related to protection of space from human intervention (results of space debris accumulation).

The principles of cooperation in space offered by COMEST include requirements to prevention of conflicts, including in the sphere of commercialization, which are possible due to expanded participation in space programs by countries and individuals, fair and equal use of resources, interaction in the area of environmental protection, regulation of technological achievements in safety standards at the international, regional and national levels of cooperation.

Preserving the peaceful nature of space exploration is crucial. This also applies to the potential for finding extraterrestrial life. The human desire for peaceful coexistence in space is delivered through messages sent beyond the Solar System by the Pioneer-10 and Pioneer-11 probes [9]. Any international agreement on the exploration and exploitation of outer space must meet the criteria of transparency and ensure access to reliable monitoring technologies for all interested parties.

Stating that the development of space research and space exploration projects requires updated ethical standards, the World Commission on the Ethics of Scientific Knowledge and Technology has adopted recommendations for peaceful ethical space exploration. In addition to the general provisions for international cooperation, a balanced assessment of potential benefits and risks, equal access and allocation of resources, including knowledge and innovation, transparency and accountability, COMEST proposed the space ethics scale as a communication tool to convey multi-level information and facilitate dialogue among all participants.

The space ethics scale will make it possible to systematize information about the ethical factors of uncertainty, risks and consequences of risks associated with initiatives in space exploration and exploitation. The structure of ethical factors can be used in correlation with natural disaster warning systems, indicators of possible UV exposure and damage to the ozone layer, monitoring of near-Earth space and other safety criteria. Ethical criteria will become a tool for adapting to the changing needs of space exploration and exploitation.

Humans have ethical obligations towards space and space resources, particularly for the future of the field. The obligations should be implemented based on a wide axiological range of economic, ecological, esthetic and other values.

Space ethics requirements should become the basis for legal standards in the development of space projects. Ethical factors shape the progress of space biology, space medicine, and space psychology, as well as the development of space programs involving humans, not only through experimental determination of its adaptive capabilities, but also using a broader understanding of these disciplines as **human sciences** that explore both physiological and spiritual resources of humans [10].

COOPERATION IN THE FIELD OF SPACE EXPLOITATION

On October 27, 2017, the first UNESCO Medal on Space Science was awarded at the organization's headquarters in Paris to recognize achievements in space exploration. The award was given to Valentina Vladimirovna Tereshkova. When receiving the UNESCO medal, the first female cosmonaut emphasized that "space should be an arena of peaceful cooperation" [11].

The International Space Station (ISS) is a prime example of successful international partnership in space exploration, involving the space agencies of Russia (Roscosmos), the United States (NASA), Japan (JAXA), Canada (CSA), and Europe (ESA). Since its first module launched in 1998, it has become a multipurpose space research laboratory where these agencies cooperate on national space scientific programs [12].

The fight against space debris is being coordinated. According to the Interagency Space Debris Coordination Committee (IADC) for 2023, over 30,000 pieces of space debris larger than 10 cm and about 900,000 objects larger than 1 cm are concentrated in low-Earth orbit (LEO). In July 2023, The Office of Space Trade has approved the Traffic Coordination System for Space roadmap, and the European Space Agency announced its Zero Debris Charter to achieve zero debris by 2030 [13].

On June 16, 2021, Roscosmos and China National Space Administration (CNSA) held a joint session to present the roadmap for the International Lunar Research Station (ILRS). This project aims to create a research facility on the Moon's surface or in orbit to conduct multifunctional scientific research and support future human presence.

Russia together with Belarus, Kazakhstan and Armenia develop cooperation in the space sector. An international partnership is continuing to utilize several neutron instruments such as the HAND on NASA's Mars Odyssey, the LAND on NASA's Lunar Reconnaissance Orbiter (LRO), and the DAN on NASA's Curiosity rover, as well as the Spektr-RG and Konus-Wind projects.

Russia and Europe continue their cooperation through numerous projects including Soyuz at the Guiana Space

Center (Russia-France), ExoMars-2016, Bepi-Colombo, and Mars Express projects of Roscosmos and the European Space Agency (ESA). Russia has developing space partnerships with Spain (World Space Observatory-Ultraviolet), Germany (Spektr-RG), Brazil, Nicaragua, and the South African National Space Agency (SANSA) [14].

The Russian Federation supports international cooperation and remains one of the leaders in space programs. Russian cosmonaut Valery Vladimirovich Polyakov holds the record for the longest single spaceflight, with a duration of 437 days, 17 hours, 58 minutes, and 17 seconds aboard the Mir space station from January 1994 to March 1995. Russian cosmonaut Gennady Ivanovich Padalka holds the world record for total time in orbit with a duration of 878 days, 11 hours, 29 minutes, and 36 seconds during 5 flights, registered by the International Aviation Federation (FAI) in September 2015 [15].

Space monitoring is vital for the successful development of terrestrial resources, including the ones in the Arctic region [16]. According to the leading experts of the Space Research Institute of the Russian Academy of Sciences, Arctic exploration is a major driver of its 21st-century development for Russia [17]. Mutual international cooperation to ensure space exploration and exploitation and to use space technology for terrestrial resource management based on pressing values of the civilization can be possible if the world community participates in the bioethical discussion of vital issues of science and technology development.

CONCLUSIONS

Sustainable principles for the ethical regulation of space programs must balance human spaceflight risks and benefits with environmental factors.

According to the World Commission on the Ethics of Scientific Knowledge and Technology, basic principles of space ethics include equative justice and fairness, nonmaleficence and beneficence and respect, and the precautionary principle. They form the basis of the space ethics scale as a communication tool to convey multi-level information and facilitate dialogue among all participants.

Space ethics requirements should become the foundation for legal standards in the development of space projects. Development of space programs involving humans is possible due to the progress of space biology, space medicine, and space psychology, and also using a broader understanding of these disciplines as human sciences that explore both physiological and spiritual resources of humans, and their ability to adaptation in a new physical and cultural reality.

The future of space research also depends on society developing a mature and scientifically informed view of space exploration, moving beyond simplistic portrayals common in popular culture. In this aspect, scientific and educational work, museum and media projects reflecting real achievements in the space industry can substantiate humanistic values in the study of the universe.

International cooperation in space is crucial for activities such as maintaining the ISS, combating space debris, planning future projects like a lunar station, and using space technology for Earth resource exploration, including in the Arctic.

Bioethical discussions, addressing a wide range of issues from technological challenges to the humanistic values, are essential for implementing the goals of space exploration.

The COMEST concept note on ethical considerations highlights that “space is a hostile environment that will always pose challenges to human endurance and spirit”.

References

1. Ministerstvo inostrannykh del Rossiyskoy Federatsii. Available from URL: https://www.mid.ru/ru/detail-material-page/1762780/. (accessed: 27.02.2025) Russian.
2. Organizatsiya Ob”yedinennykh Natsiy. Konventsii i soglasheniya. Available from URL: https://www.un.org/ru/documents/decl_conv/conventions/astronauts_rescue.shtml (accessed: 27.02.2025) Russian.
3. GARANT. Konventsiya o mezhdunarodnoy otvetstvennosti za ushcherb, prichinennyy kosmicheskimi ob”yektami (Moskva — London — Vashington, 29 marta 1972 g.). Available from URL: https://base.garant.ru/2540324/ (accessed: 27.02.2025) Russian.
4. Organizatsiya Ob”yedinennykh Natsiy. Konventsii i soglasheniya. Available from URL: https://www.un.org/ru/documents/decl_conv/conventions/objects_registration.shtml (accessed: 27.02.2025) Russian.
5. Organizatsiya Ob”yedinennykh Natsiy. Rezolyutsiya, prinyataya General’noy Assambleyey 20 oktyabrya 2004 goda. Available from URL: https://documents.un.org/doc/undoc/gen/n04/476/34/pdf/n0447634.pdf (accessed: 27.02.2025) Russian.
6. UNESCO. Peresmotr Ustava Vsemirnoy komissii po etike nauchnykh znaniy i tekhnologiy (KOMEST). Available from URL: https://unesdoc.unesco.org/ark:/48223/pf0000183635_rus (accessed: 27.02.2025) Russian.
7. UNESCO. Concept note of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) on the Ethical Considerations on Space Exploration and Exploitation. Available from URL: https://unesdoc.unesco.org/ark:/48223/pf0000390844 (accessed: 27.02.2025)
8. NASA. Available from URL: https://www.nasa.gov/feature/artemis/ (accessed: 27.02.2025)
9. NASA. Pioneer 10. Available from URL: https://science.nasa.gov/mission/pioneer-10/ (accessed: 27.02.2025)
10. Razumov AN, Ushakov IB, Bogomolov AV. Razvitiye kosmicheskoy psikhologii v trudakh nauchnoy shkoly akademika V. A. Ponomarenko. Sovremennoye sostoyaniye i vektory razvitiya aviatsionnoy i kosmicheskoy meditsiny: Materialy Vserossiyskoy nauchno-prakticheskoy konferentsii, posvyashchennoy 65-letiyu kafedry aviatsionnoy i kosmicheskoy meditsiny Voyenno-meditsinskoy akademii imeni S. M. Kirova. Voyenno-meditsinskaya akademiya Kirova. 23 noyabrya 2023 goda. Sankt-Peterburg: Voyenno-meditsinskaya akademiya. Kirova. 2023; 12–20. Russian.
11. TASS. Valentina Tereshkova nagrazhdena medal’yu YUNESKO za dostizheniya v issledovanii kosmosa. Available from URL: https://tass.ru/kosmos/4684224 (accessed: 27.02.2025) Russian.
12. Roskosmos. Mezhdunarodnaya kosmicheskaya stantsiya. Available from URL: https://www.roscosmos.ru/202/ (accessed: 28.02.2025) Russian.
13. Natsional’nyy issledovatel’skiy universitet «Vysshaya shkola ekonomiki». Ot novogo kosmosa k ekonomike zvezd: kakiye vyzovy stoyat pered osvoyeniyem okolozemnoy orbity. Available from URL: https://economics.hse.ru/ecjourn/news/890272912.html (accessed: 28.02.2025) Russian.
14. Mezhdunarodnyye proyekty Goskorporatsii «Roskosmos». Available from URL: https://www.roscosmos.ru/22888/ (accessed: 28.02.2025) Russian.
15. TASS. Kosmicheskiye rekordy. Available from URL: https://tass.ru/spravochnaya-informaciya/3189734 (accessed: 02.03.2025) Russian.
16. Rossiyskiye kosmicheskiye sistemy. Poluchen pervyy snimok s KA «Arktika-M» № 2. Available from URL: https://ntsomz.ru/image-1-arctica-m-2/ (accessed: 04.03.2025) Russian.
17. Zelenyy LM, Petrukovich AA. Institut kosmicheskikh issledovaniy Rossiyskoy Akademii Nauk. Arktika. Kosmicheskaya pogoda Available from URL: https://iki.cosmos.ru/popular/articles/arktika-kosmicheskaya-pogoda. (accessed: 04.03.2025) Russian.

Литература

1. Министерство иностранных дел Российской Федерации. Режим доступа: [Электронный ресурс] URL: https://www.mid.ru/ru/detail-material-page/1762780/. (дата обращения: 27.02.2025).
2. Организация Объединенных Наций. Конвенции и соглашения. Режим доступа: [Электронный ресурс] URL: https://www.un.org/ru/documents/decl_conv/conventions/astronauts_rescue.shtml (дата обращения: 27.02.2025).
3. ГАРАНТ. Конвенция о международной ответственности за ущерб, причиненный космическими объектами (Москва — Лондон — Вашингтон, 29 марта 1972 г.). Режим доступа: [Электронный ресурс] URL: https://base.garant.ru/2540324/ (дата обращения: 27.02.2025).
4. Организация Объединенных Наций. Конвенции и соглашения. Режим доступа: [Электронный ресурс] URL: https://www.un.org/ru/documents/decl_conv/conventions/objects_registration.shtml (дата обращения: 27.02.2025).
5. Организация Объединенных Наций. Резолюция, принятая Генеральной Ассамблеей 20 октября 2004 года. Режим доступа: [Электронный ресурс] URL: https://documents.un.org/doc/undoc/gen/n04/476/34/pdf/n0447634.pdf (дата обращения: 27.02.2025).
6. UNESCO. Пересмотр Устава Всемирной комиссии по этике научных знаний и технологий (КОМЕСТ). Режим доступа: [Электронный ресурс] URL: https://unesdoc.unesco.org/ark:/48223/pf0000183635_rus (дата обращения: 27.02.2025).
7. UNESCO. Concept note of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) on the Ethical Considerations on Space Exploration and Exploitation. Режим доступа: [Электронный ресурс] URL: https://unesdoc.unesco.org/ark:/48223/pf0000390844 (дата обращения: 27.02.2025).
8. NASA. Режим доступа: [Электронный ресурс] URL: https://www.nasa.gov/feature/artemis/ (дата обращения: 27.02.2025).
9. NASA. Pioneer 10. Режим доступа: [Электронный ресурс] URL: https://science.nasa.gov/mission/pioneer-10/ (дата обращения: 27.02.2025).
10. Разумов А. Н., Ушаков И. Б., Богомолов А. В. Развитие космической психологии в трудах научной школы академика В. А. Пономаренко. Современное состояние и векторы развития авиационной и космической медицины: Материалы Всероссийской научно-практической конференции, посвященной 65-летию кафедры авиационной и космической медицины Военно-медицинской академии имени С. М. Кирова. Военно-медицинская академия имени С. М. Кирова. 23 ноября 2023 года. Санкт-Петербург: Военно-медицинская академия им. С. М. Кирова, 2023; 12–20.
11. ТАСС. Валентина Терешкова награждена медалью ЮНЕСКО за достижения в исследовании космоса. Режим доступа: [Электронный ресурс] URL: https://tass.ru/kosmos/4684224 (дата обращения: 27.02.2025).
12. Роскосмос. Международная космическая станция. Режим доступа: [Электронный ресурс] URL: https://www.roscosmos.ru/202/ (дата обращения: 28.02.2025).
13. Национальный исследовательский университет «Высшая школа экономики». От нового космоса к экономике звезд: какие вызовы стоят перед освоением околоземной орбиты. Режим доступа: [Электронный ресурс] URL: https://economics.hse.ru/ecjourn/news/890272912.html (дата обращения: 28.02.2025).
14. Международные проекты Госкорпорации «Роскосмос». Режим доступа: [Электронный ресурс] URL: https://www.roscosmos.ru/22888/ (дата обращения: 28.02.2025).
15. ТАСС. Космические рекорды. Режим доступа: [Электронный ресурс] URL: https://tass.ru/spravochnaya-informaciya/3189734 (дата обращения: 02.03.2025).
16. Российские космические системы. Получен первый снимок с КА «Арктика-М» № 2. Режим доступа: [Электронный ресурс] URL: https://ntsomz.ru/image-1-arctica-m-2/ (дата обращения: 04.03.2025).
17. Зеленый Л. М., Петрукович А. А. Институт космических исследований Российской Академии Наук. Арктика. Космическая погода. Режим доступа: [Электронный ресурс] URL: https://iki.cosmos.ru/popular/articles/arktika-kosmicheskaya-pogoda. (дата обращения: 04.03.2025).