A Study on the Strengthening Space Cooperation between South Korea and the EU

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Abstract

After exploring ways to strengthen space cooperation between South Korea and the European Union to improve South Korea's space competitiveness in the new space era, this study seeks to propose five policy suggestions. First, space technology development and international cooperation should be strengthened to respond to changes in the global space development environment and to realize Korea's space economy in the future. Second, it is essential for South Korea to closely monitor and analyze the international space development situation, such as Europe's space strategy and space program, develop its future space policy, and implement its space development plans. Third, international cooperation in space activities will allow the possible recruitment of excellent space personnel and cultivate future national talent. Fourth, in response to the recent space threats from Russia and China, South Korea and European countries should strengthen their cooperation in the defense sector. Fifth, by establishing and operating the Korea Aerospace Agency (KASA), South Korea should manage its space activities and promote cooperation with the space organizations of advanced countries.

Keywords: *Space cooperation, Space development, space power, European Space Agency(ESA), Korea Aerospace Agency(KASA)*

Introduction

In November 2022, President Yoon Suk Yeol announced a roadmap for the future space economy. It included policy directions for the Republic of Korea to become a space economy powerhouse by 2045. The six policy directions were to explore the moon and Mars, leap forward as a space technology powerhouse, foster the space industry, foster space talent, realize space security, and lead international cooperation.[1] President Yoon proposed a blueprint to strengthen cooperation with advanced space developers to expand South Korea's economic sphere to space and grow South Korea's space power.

In the era of New Space, where the private sector emerges as the subject of space technology innovation, major space-advanced countries are creating innovative space technology and strengthening their competitiveness in the space industry through cooperation between the private sector and the government. In addition, global companies are competing to dominate new markets such as the space Internet and space tourism services, providing new services such as reusable projectiles and space debris removal.[2] Europe's space industry accounts for more than 20% of the global market in the space sector, creating economic value for Europe.[3] Korea's international cooperation and technological exchanges with European countries over the years have facilitated its space development.

Until now, research on Europe's space activities has been focused on analyzing the European Union's space programs, such as the role of space in implementing the European Union's joint security and defense policy and European space exploration from a science and technology diplomatic perspective. Chung Young-jin assessed that the European Union is trying to gain political and economic independence in the international community through space and take the lead in international relations by becoming the global powerhouse in science and technology.[4] Choe Nam-mi proposed some policy implications for South Korea's space exploration strategy through her analysis of European space policy and space exploration, which are fully diplomatic in the field of space.[5] Jeong

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1) Presidential Office, "President Yoon Announces Future Space Economy Roadmap," Nov. 28, 2022, https://www.president.go.kr/newsroom/press/Uc8g7TAf(accessed on April 28, 2023).

2) Ahn Hyun-joon and Park Hyun-joon. 2021. "A plan to expand public-private cooperation to enhance the competitiveness of the space industry in the new space era." *STEP Insight,* No. 273, 2021.

3) European Commission, "The future of theEuropean space sector," 2019, https://www.eib.org/attachments/thematic/future_of_european_space_sector_en.pdf.

4) Jung Young-jin. "The role of the Universe in the Implementation of the Common Security and Defense Policy of the European Union." Journal of aerospace policy and law 34, no.2 (2019): 329-346.

5) Choe Nammi, "Europe's Space Exploration and Korea's Space Exploration Strategy from the Perspective of Science and Technology Diplomacy." J. Space Technol. Appl. 2022;2(3):195-205.

Seo-young analyzed the latest technology strategy of the European Space Agency and explained the current status of space technology development that actively reflects industrial demand to strengthen industrial competitiveness in the space field.[6] The previous studies above suggest that in developing space technology, space exploration, and joint security defense in Europe, the role of space is indispensable, but in-depth research is needed on major issues of space cooperation and ways to strengthen cooperation between South Korea and the European Union in the era of the Fourth Industrial Revolution.

The European Union is trying to ensure safe space use and implement continuous space activities through cooperation with partner countries in space exploration and space situational awareness, which use huge budgets. In a situation where cooperation in international space activities is expected to be strengthened, Korea should develop space science and technology and actively participate in international cooperation. This study aims to identify tasks for space cooperation between South Korea and the European Union, and to find out the issues concerning space development and ways to strengthen cooperation between South Korea and the European Union. It is crucial that in response to the recent threats from China and Russia in space, they establish a strategy to strengthen space capabilities as partners in space cooperation while utilizing and supplementing the strengths and weaknesses of their space development capabilities.

Space Activity Cooperation Trend

Changes in the Global Space Activity Environment

Due to the development of private capital and high-tech capabilities in the new space era, the private sector has expanded its role in government-led space development, making the private sector the subject of space technology innovation. Competition for space exploration is expanding around the world, with space-advanced countries planning manned exploration activities to the Moon and Mars. In 2022, South Korea launched a lunar orbiter, which it has been operating to conduct research and explore lunar resources. Advanced space countries have established and promoted space activity policies focusing on expanding space exploration and fostering the private space industry. It promotes understanding of the universe and creates new values and economies through new technologies. Large-scale budget space exploration, satellite navigation system construction, and space security are areas where international cooperation is increasing because it

6) Soyoung Chung, Gi Won Nam, "European Space Technology Coordination & Planning and ESA's Technology Strategy," Korean Aerospace Society Academic Presentation, pp. 263-264.

enables the continuous operation of space programs and the safe use of space services. Recently, the international community has focused on efforts to solve common problems such as climate change, food security, disaster, medical and education, and space debris by utilizing space technology and assets. As space technology improves the quality of life and becomes a vital factor in social and economic development, cooperation in space is increasing.[7)]

Scope and object of space cooperation

Before we examine the Korea-EU space cooperation, a discussion on international cooperation, in general, would be helpful. Space technology and space system development capabilities are crucial for private-led space development in the new space era. In addition, the demand for space exploration for resource acquisition and space environment research is increasing, while it has become essential for any space activities to possess space operational capabilities for the safe protection and operation of space assets. In this study, we seek to analyze joint space activities between Korea and the European Union and propose cooperative measures involving four factors: satellite navigation and satellite utilization; space exploration; space situational awareness; and human resources training in the space sector. The first is satellite navigation and satellite utilization. Europe has advanced satellite navigation capabilities thanks to the development of the Galileo satellite navigation system. As it implements the Korean Positioning System (KPS) project, Korea must work with the European Union to develop a successful Korean Satellite Navigation System as it did in 2006. Second, through space exploration and space environment research, Korea and the European Union should exchange basic space science data by conducting joint research on manned space exploration, asteroid monitoring, and space environments such as the Moon and Mars. Third, space surveillance and space tracking capabilities should be strengthened to protect space infrastructure and secure resilience. They ensure safe space service by monitoring collisions in space and ground falls of space debris. Fourth, South Korea and the European Union should jointly cultivate human resources in the space field. By strengthening human exchanges in the space sector, they should cultivate space personnel and promote cooperation in science, technology, engineering, and mathematics (STEM) education.

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7) Jeong Heon-joo, Baek Yu-na and Jeong Yoon-young. “Space and international development cooperation: an exploratory analysis of the achievement of sustainable development goals using space technology.” *Social science research* 33, no. 2 (2022): p. 129; McClintock, Bruce, Katie Feistel, Douglas C. Ligor, and Kathryn O'Connor, *Responsible Space Behavior for the New Space Era: Preserving the Province of Humanity*. Santa Monica, CA: RAND Corporation, 2021. https://www.rand.org/pubs/perspectives/PEA887-2.html(accessed on April 29, 2023); Bank of America Institute, “The New Space Era: Expansion of the Space Economy,” January 27, 2023.

The scope and targets of Korea-EU space cooperation are as follows.

<Table 1> Scope and target of South Korea-EU space cooperation

Category	Area of space cooperation	Details
South Korea-EU space cooperation	Satellite Navigation and Satellite Application	Global satellite navigation service, KPS development technology cooperation, and space application
	space exploration	Activities to explore space and find resources using robot technology on the Moon and Mars
	Space Situational Awareness	Space Surveillance, space debris, Joint Response to Space Threats
	Human Resources Development in Space Technology	Exchange program, STEM field education cooperation, ESA student internships program

South Korea-EU Space Policy

EU Space Policy and Space Strategy

EU's space policy

The European Union has been active in drafting and implementing space policy, which enables the EU to set goals for job creation, investment support, and competitiveness in various industries related to space science and technology, data, and services, and to promote various projects.[8] Europe's space policy focuses on building the world's best space system and using and disseminating the data collected for the public interest. For example, the EU uses satellite images of observation satellites, uses communication satellites and sends rescue teams to the locations where natural disasters have occurred, and finds ways to use transportation and energy infrastructure more safely by improving land use in the agricultural sector. One of the notable policy goals of the EU is to provide many business opportunities to EU member states in the space data and digital technology sectors.[9] The European Space Agency (ESA) is a pan-European public institution that not only provides European member states with space industry infrastructure but also controls joint programs for research and development activities.[10] The European

8) Ahn Hyun-joon, "A Proposal of National Space Governance Reform according to Expansion of Space Development", *Policy Research* 2022-24, 2022, p.53

9) Ahn Hyunjoon, p. 55.

Space Agency (ESA) was established in 1975 to achieve Europe's independent space development; now it is a non-EU organization involving Canada as a partner along with 22 European countries. In Europe, commercialization activities in space are prioritized as interest in space utilization increases.

In December 2018, the European Council adopted the regulations proposed by the European Commission on the installation of the EU Space Program and Space Agency for 2021-2027. The EU Space Development Program consists of five projects in the fields of satellite navigation, earth observation, and security.[11] In the field of satellite navigation, the Galileo Global Navigation Satellite System (GNSS), which consists of 28 satellites in Earth's orbit, and operating satellites in geostationary orbit provide the GPS error correction service.[12] The Galileo satellite was first launched in 2011 and became fully operational in 2020. The Copernicus project, which falls in the field of earth observation, aims to develop and operate earth observation satellites that observe the earth's atmosphere, marine environment, land use, and climate change.[13] It aims to develop a total of five Sentinel satellites to utilize satellite information and actively participate in international sharing and utilization of earth observation data to strengthen European space diplomacy on the international stage. The security field concerns Space Situational Awareness (SSA) capabilities and aims to develop government satellite communication networks for border and marine monitoring, disaster and crisis management, and humanitarian activities. The EU emphasizes the security aspects of space development, Europe's independent space development and use, and the paradigm shift of the space development industry involving the private sector in the new space era.

the EU's space strategy

In 2016, the European Union announced its space strategy for Europe to maximize the benefits of the space industry for economic development, secure stability and autonomy in space, and strengthen international cooperation.

In 2016, the European Commission announced Europe's first comprehensive European space strategy to respond to growing global competition in space, promote European leadership, expand its share in the space market, and seize the benefits and opportunities of space. Among the five strategic goals of the European space strategy

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10) Sangwoo Shin. (2019). "The Changes of Big Science Policies: exploring value creation programmes in the US and European Space Agency," Conference of the Korean Society for Technology Innovation, (2019), p. 11.

11) Ministry of Foreign Affairs, EU plans for 2021-2027 space development, Jan. 23, 2019, https://www.mofa.go.kr/be-ko/brd/m_7570/view.do?seq=1286193 (accessed: 2023.4.29).

12) ESA, "What is Galileo?," https://www.esa.int/Applications/Navigation/Galileo/What_is_Galileo, https://www.euspa.europa.eu/european-space/egnos/what-egnos.

13) Europe's eyes on Earth, https://www.copernicus.eu/en (accessed:2023.4.29.).

were maximizing the use of space for European society and economy, fostering the European space sector globally competitively and innovatively, strengthening Europe's independent access and use of space in a secure environment, and promoting international cooperation. To achieve the fourth strategic goal, the EU engaged in space dialogue with overseas strategic partners, economic diplomacy support for overseas activities of European companies, contribution to international joint problems, and participation in protecting the space environment.[14)]

Europe announced its 2016 European Space Strategy that aimed to contribute to the establishment of high-level missions and infrastructure required by defense and security by increasing synergy in space technology, infrastructure, and services through civil-military cooperation with ESA and EDA.[15)]

Space Policy of Major European Countries

France boasts the highest budget for space programs in the European Space Agency (ESA). France presented the following four policy directions when it published its space strategy in 2012. First, it plays a leading role in the field of European space. Second, it maintains independence in space technology and space access. Third, it will accelerate the development of high-value-added satellite information utilization fields. Fourth, it would attempt ambitious space-related industrial policies. The French government and the French National Space Agency (CNES) have established plans to accelerate innovation to improve the competitiveness of the French space industry and use satellites and strengthen global warming monitoring to strengthen international cooperation and meet people's living services.[16)]

Germany's space policy had long focused on three areas: science, space transport, and infrastructure. In 2001, however, its primary focus shifted to the utilization (satellite communication and earth observation) and commercialization of the space sector were emphasized. In 2005, the German government began to show more interest in space exploration based on the technological development of its robot field. Germany’s last national space strategy was announced in 2010, which aimed to develop its space industry to suit the future, was published. It proposed that the space industry should be used to not only maintain a leading position in innovation and technology but also respond to globalization, the advent of a knowledge society,

14) EUSPA, New Space Strategy for Europe launched at the European Space Expo, https://www.gsc-europa.eu/news/new-space-strategy-for-europe-launched-at-the-european-space-expo-3(accessed on April 28, 2023); Choe, Nammi. “Europe’s Space Exploration and Korea’s Space Exploration Strategy from the Perspective of Science and Technology Diplomacy.” Journal of Space Technology and Applications. The Korean Space Science Society, September 2022, p. 197.

15) Ahn Hyunjoon, “A Proposal of National Space Governance Reform according to Expansion of Space Development,” Policy Research 2022-24, p. 39.

16) Ministry of ICT, Space development white paper (2022), pp. 86-87.

climate change, and security threats. The German Aerospace Center (DLR) is in charge of managing the space program. DLR is pursuing R&D activities in a wide range of fields such as aerospace.[17)]

Italy announced its 2016-2025 strategic vision in 2016, strengthening its national status through international cooperation by utilizing space-based services for the space economy, contributing to the development of national science. In addition, space service was launched thanks to investment in satellite communication and satellite navigation and it is contributing greatly to the International Space Station program in the field of space exploration, a traditional area of interest.

South Korea's Space Policy and Space Power

South Korea's Space Policy

To expand private companies' participation in space development projects in the era of New Space, where the private sector leads the space industry, Korea reviewed and confirmed the 3rd Basic Plan for Space Development at the Korea-U.S. Summit in June 2021. The Yoon Suk Yeol government announced a roadmap for the future space economy with policy objectives in effect until 2045 that aimed to help Korea become a space economy powerhouse. The six major policy directions were to lead the exploration of the Moon and Mars, become a space technology powerhouse, foster the space industry, cultivate space talent, realize space security, and form international cooperation.

In December 2022, the National Space Development Committee chaired by the Prime Minister deliberated and finalized the 4th Basic Plan for Space Development Promotion, a key space development project.

The 4th Basic Plan for the Implementation of the Future Space Economy Roadmap aims to expand investment in space development and increase Korea's share of the global market from 1% to 10% by 2045. It established five long-term space development missions for the Korean space economy.[18)]

1) expand space exploration: The South Korean government announced its goal of landing on the moon by 2023 and landing on Mars by 2045, pushing for its own space exploration plan to expand its space economy territory. It will secure unmanned exploration capabilities independently and strategically promote manned space stations and exploration bases through international cooperation.
2) Complete space transport capabilities: Korea plans to complete its space

17) Ministry of ICT, Space development white paper (2022), pp. 89-90.

18) Ministry of ICT, “The 4th Basic Plan for Space Development Promotion ('23-27),” https://www.msit.go.kr/publicinfo/view.do?sCode=user&mPid=62&mId=63&publictSeqNo=3&publictListSeqNo=3&formMode=R&referKey=3,3 (accessed on April 28, 2023).

transport capacity and build a base as a hub for space transport in Asia. It plans to develop unmanned transport capacity by improving launch capacity by 2030 and manned transport projectiles by 2045.

3) Create the space industry: Seoul plans to develop the space industry into a major industry to build a world-class industrial ecosystem.
4) Establish space security. To ensure a safe life for the people, the South Korean government plans to build a space strategy that enables international cooperation by strengthening its capacity to prepare for space risks such as space object collisions and falls and expanding space assets for national security.
5) Expand space science: South Korea plans to lead space research worldwide by securing research capabilities on space science and introducing long-term space science research programs.

South Korea's space power

South Korea succeeded in developing and launching the Korean-style Space Launch Vehicle Nuri, which could launch a 1.5-ton practical satellite, in June 2022. In May 2023, a next-generation small satellite manufactured in Korea will be directly mounted on the Korean space launch vehicle Nuri to carry out the third launch. It is significant as it launches a domestic practical satellite using a domestic space launch vehicle developed by South Korea.[19] The establishment of independent space transport capacity thanks to the reliability of South Korea's space launch vehicle production will provide space capabilities for South Korea.

South Korea has been developing and operating multi-purpose practical satellites, the earth observation satellites. Multi-purpose practical satellites are low-orbit earth observation satellites that secure various satellite data through payloads such as electronic optical cameras, image radar, and infrared cameras; their main uses are for land and marine monitoring, weather, geology, agriculture, water resources, and disaster response.[20] In the geostationary orbit, satellites for maritime and weather observation are developed to provide services to the public sectors. The South Korean military is working on a reconnaissance satellite project to strengthen its intelligence surveillance and reconnaissance capabilities and is developing major sensors for satellites through international cooperation.

The Korea Satellite Navigation System (KPS) construction project, which will cost 3.7 trillion won, is to develop its own satellite navigation system that provides position, navigation, and time (PNT) information essential for the operation of

19) Choi Ji-won, "180kg small satellite, our technology projectile... The first step in revitalizing the domestic space industry," *Dong-A Ilbo*, 2023.4.25., https://www.donga.com/news/It/article/all/20230425/118988168/1

20) KARI, "Korea Multipurpose Satellite(Arirang)," https://www.kari.re.kr/kor/sub03_03_01.do(accessed on April 28, 2023).

national core infrastructure such as transportation, communication, and finance. Currently, South Korea relies on GPS operated by the U.S. for satellite navigation services. The KPS project aims to develop KPS satellite systems, ground systems, and user systems from 2022 to 2035 and to operate its own system by placing a total of eight satellites in orbit. If South Korea succeeds in building the KPS, it will become the seventh country in the world to have its own navigation satellite system after the U.S., Russia, the European Union, China, India, and Japan.[21] Just as 300 private companies participated in the Nuri development project to create an ecosystem for the space industry and boost technology, the KPS project will provide a valuable opportunity for domestic space companies to secure technology and gain satellite launch experience.

In response to the new space era, South Korea decided to establish the National Aeronautics and Space Administration to carry out the country's leading mission to develop the space economy through space development. President Yoon Suk Yeol visited NASA on April 25, 2023, to establish a NASA-like Korea Aerospace Agency (KASA) that would lead the Korean space economy and emphasize the importance of Korea-U.S. space cooperation in the future. In addition, the Ministry of Science and ICT and NASA signed a joint statement between South Korea and the U.S. on cooperation in space exploration and space science. South Korea will strengthen cooperation with the United States to collaborate on joint tasks in areas such as lunar exploration programs, satellite navigation systems, and space exploration.[22] The South Korea-U.S. space technology alliance agreement will serve as an invaluable opportunity for South Korea's future development in the space sector.[23]

For South Korea to succeed in space development, it needs to expedite the special law of the National Aeronautics and Space Administration, secure a sufficient budget, create private funds, develop core technologies, and create a private space ecosystem.[24]

The U.S. has the largest budget of $61,967 million among all countries' space budgets, including China's at $11,935 million, France's at $4,204 million, Germany's at $2,527 million, and Italy's at $1,736 million. Korea's budget of $7.24 million is far short of the space budget when compared to space-advanced countries. It is imperative that the South Korean government increase the budget and implement the space power generation plan to improve Korea's national space technology.

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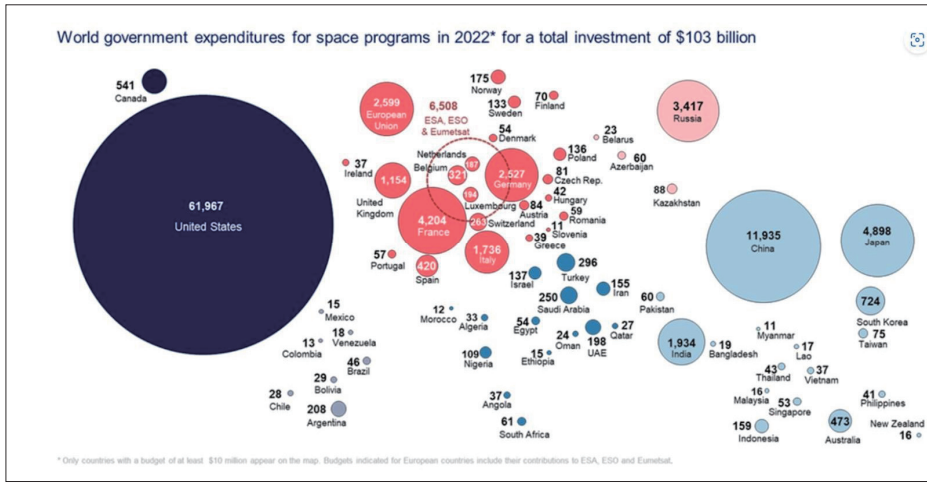
21) Ko Jae-won, "Development of the K Satellite Navigation System 'Long March'" *Dong-A Science*, https://www.dongascience.com/news.php?idx=58525 (accessed on April 28,2023).

22) Jeon Ju-young, "Finding NASA, expanding the space alliance between the two countries into space security," *Dong-A Ilbo*, 2023.4.27., https://www.donga.com/news/Politics/article/all/20230427/119028304/1

23) Kim Min-seok, "The urgency of the Korea-U.S. Space Alliance and the Space Agency Act," *Munhwa Ilbo*, 2023.4.28., https://www.munhwa.com/news/view.html?no=2023042801033311000002.

24) Kim Min Seok, 2023.

<Figure 1> World government expenditures for space program in 2022



Source: Euroconsult, "Government Space Programs" 2021, https://www.euroconsult-ec.com/press-release/new-record-in-government-space-defense-spendings-driven-by-investments-in-space-security-and-early-warning/(accessed on April. 28, 2023).

Challenges and Strategies for Strengthening South Korea-EU Space Cooperation

South Korea-EU Space Development Cooperation System

South Korea-EU space cooperation in the private sector precedes governmental cooperation. South Korea collaborated with a U.S. satellite manufacturing company to develop a multipurpose satellite in the 1990s. Since then, satellite development and production have mainly been through technical cooperation with leading European aerospace companies, Airbus and Thales. Cooperation on satellite navigation between the South Korea government and the European Space Agency (ESA), established through cooperation among European governments, is underway. Korea signed a cooperation agreement with the European Union in 2006 to participate in the Galileo project, the European satellite navigation system that began operation in 2016. The agreement was ratified in 2015, and the South Korea-EU cooperation agreement took effect in 2016.[25] The South Korean government signed agreements with the European Space Agency in

25) Ministry of ICT, Space development white paper (2022), p. 292.

2011 and 2016 to collaborate on the European Space Agency's launch tracking operation and promoted Soyuz and Vega launch tracking cooperation, using the Korea Aerospace Research Institute's Jeju tracking station. KARI and ESA continue to hold bilateral meetings to facilitate exchanges between the two agencies, including signing business agreements to promote cooperation in the space sector.

France is the first country in Europe to launch a national space program. Its space industry has a huge influence on the entire European space market. After signing a memorandum of understanding with the French National Space Research Center (CNES) in 1990, KARI co-developed a Chollian satellite, which would provide weather and maritime information in geostationary orbit, developed parts of the Earth observation satellite, and cooperated with the CNES on the Naro Space Center launch pad. It also signed an MOU with the International Space University (ISU) to promote international space exchange programs.

Since the 2000s, South Korea has been working closely with the German Aerospace Center (DLR) on satellite components such as multi-purpose practical satellite optical payload parts and SAR radar payload parts. It also cooperated with the DLR to install and operate multi-purpose practical satellites in Germany for overseas ground stations.

In the defense sector, South Korea is developing payload sensors for the reconnaissance satellite business with Italy while holding a defense space cooperation meeting between Korea and France to exchange professional personnel and respond to space threats.

South Korea and Europe have participated in the International Astronautical Congress (IAC) to continue cooperation in space and space training programs between the two countries through the International Space Education Board. For Korea to strengthen space cooperation with the EU, it is imperative to reinforce space surveillance activities such as sharing space policy information, expanding joint research cooperation on space exploration, and responding to threats in space.

South Korea-EU Space Cooperation Task and Strategy

The potential areas for the South Korea-European Union space cooperation include satellite navigation and satellite utilization, space exploration and space environment research, and space security and space situational awareness. Space cooperation between South Korea and the EU is very essential for South Korea's future space science and technology and space power.

Satellite Navigation and Satellite Application

Satellite utilization offers greater economic value than satellite manufacturing and projectile services. Recently, international cooperation concerning satellite utilization, such as artificial intelligence technology, global satellite Internet

network construction projects, and satellite data sharing, has been increasing. Since South Korea has excellent science and technology ability to predict climate change and disasters through satellite image analysis, such as artificial intelligence and big data analysis, it can enhance cooperation with the European Union by promoting more investment and exchanges in satellite utilization.

Space exploration and space observation research

1) Space exploration program

Through cooperation on space exploration and space environment research, South Korea and the EU conduct joint research on unmanned space exploration, asteroid monitoring, and space environment with attractions such as the Moon and Mars and share their findings with each other. South Korea is a member of the Artemis program, a manned lunar exploration project led by the United States, and is successfully operating a lunar orbiter. In April 2023, the Korea Institute of Geoscience and Mineral Resources (KIGAM) and the European Space Resources Innovation Center (ESRIC) agreed to conduct cooperative research on the utilization of resources on the Moon.[26)]

2) Space observation research

Solar environmental research and lunar science research are fundamental fields of astronomy. The European Space Agency, in collaboration with NASA in the United States, conducts joint research on astronomical observations and the formation of space origins and planets through the James Webb Space Telescope program.[27)] Since the Korea Astronomy and Space Science Institute (KASI) currently works with NASA on solar physics research and engages in joint overseas research such as asteroid impact test observation, it can form collaborative relationships with the EU on research concerning space astronomy.

Space Situational Awareness and Ensuring Safe Space Activity

The European Union carries out a space situation recognition project to monitor and track artifacts and satellite debris in outer space of the Earth. Recently, China and Russia have been doubling down their response to space threat activities.[28)] South Korea maintains space cooperation concerning various

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26) KIGAM, "ESRIC-KIGAM Moon resources cooperation," April 20, 2023, https://www.kigam.re.kr/gallery.es?mid=a10703010000&bid=0003&act=view&list_no=3808

27) ESA, https://www.esa.int/Science_Exploration/Space_Science/Webb(accessed on April 30, 2023).

28) China Aerospace Studies Institute, "China-Russia Space Cooperation: The Strategic, Military, Diplomatic, and Economic Implications of a Growing Relationship," May 8, 2023, https://www.airuniversity.af.edu/CASI/Display/Article/3373101/china-russia-space-cooperation-the-strategic-military-diplomatic-and-economic-i/(accessed on April 28, 2023).

space situations; for example, it shares information related to space threats through space policy dialogue with the U.S. and space situational awareness (SSA). To build joint response capabilities related to space threats, based on its experience of joint space operations with the U.S. military, the South Korean military needs to participate in joint training with European countries using reconnaissance satellites in the future.

Human Resources Development in Space

Space is a field that requires advanced science and technology capabilities. Training human resources with advanced technology capabilities such as artificial intelligence, software, and autonomous driving is essential for successful space activities. If Korean students with excellent technological skills participate in the international exchange program in the space field, Korea's international status will be enhanced. It will contribute to fostering Korean space science and technology talent by supporting Korean students' participation in international exchange programs such as ESA or internships in the European Union. With increasing global interest in Korean culture in recent years, developing and implementing space education programs incorporating Korean cultural elements into space science and technology will enhance Korean students' international competitiveness and promote international exchanges related to space education.

Conclusion

Space development cooperation between South Korea and the European Union constitutes a significant part of South Korea's space development history. Continuous technical cooperation and international exchanges with European countries helped South Korea acquire satellite and rocket technologies. Since space technology concerns national security and is advanced science and technology, it is understandable that one may be hesitant to transfer technology to other countries. To become a space economy powerhouse, Korea should invest in space development substantially and advance space technology through international exchange programs, cooperation with advanced space powerhouses, and active participation in international collaborative space programs. To begin their collaborative relations in space science and technology, South Korea and the European Union can identify specific fields for their cooperation, such as joint response to space threats, joint space exploration to secure future resources, and satellite aviation systems to improve people's life. Korea should analyze European countries' efforts and policies to maximize space use for economic development and establish and implement space cooperation development plans between Korea and the European Union.

South Korea successfully carried out satellite projects thanks to international cooperation with European countries. After the development of the Korea multi-purpose satellite 1 helped by U.S. companies, cooperation with European countries has been expanded in satellite development, improving the performance of the satellite body and payload. In addition, by using Europe's Ariane space launch vehicle to launch satellite launches, South Korea was able to solidify its status as a rightful partner of European countries in space science and technology.

The European Union strives to advance its economy,and enhance its space power via international cooperation and improved personnel training in the space sector. To strengthen space cooperation between Korea and the European Union, this study proposes the following policy suggestions.

First, space technology development and international cooperation should be strengthened to respond to changes in the global space development environment and to realize South Korea's space economy in the future. As a space-advanced country, the European Union plays a significant role in the international space market. The South Korea-EU space cooperation will help South Korea to build its space economy and emerge as an advanced space country. Space will be pivotal for South Korea as a future source of economic growth.

Second, it is imperative for South Korea to closely analyze the international space development situation, propose space policies similar to Europe's space strategy and space program, and execute space development plans. Europe’s space programs seek to serve its citizens and boost its economy. While analyzing Europe's space strategy, South Korea should identify ways to strengthen cooperation with the European Union. It should also be able to model South Korea's space policy on European space programs and implement space development plans.

Third, international cooperation in space activities will allow the recruitment of excellent space experts and foster future talent in space science and technology. Space activities do not simply affect the national economy but can cultivate South Korea's space personnel and contribute to fostering future national talent through international exchanges. South Korea should pay attention to space education and training as part of space activities that can cultivate space science talent especially as they collaborate with those from other countries.

Fourth, a joint response to the recent space threats from Russia and China could be a way to strengthen cooperation in the defense sector between South Korea and European countries. While international cooperation has been thriving in the private sector, it is rare in the defense sector. As the EU plans to strengthen space security cooperation among European countries in the defense sector and enhance space surveillance and object tracking capabilities to protect and secure space infrastructure, South Korea should promote itself as a rightful partner in space security.

Fifth, by establishing and operating the Korea Aerospace Agency (KASA),

South Korea should manage its space activities and promote cooperation with the space agencies of space-advanced countries. In 2023, a special law concerning the establishment of the KASA was enacted. The KASA will play a key role in revitalizing space cooperation between the EU and South Korea and present a future vision.

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