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Chinese Perspectives in the "Space Race" through the Prism of Global Scientific and Technological Leadership

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This study provides a philosophical analysis of the Chinese Space Program and its connection to the embodiment of "China's Dream" in the 21st century. China's current achievements and main challenges in the "space race" are observed in comparison to others' "space superpowers" practical steps. The given analysis includes reflections on geopolitical and scientific-technical aspects of China's space program and a brief history of the latter, on the development of manned spaceflight carried out by the PRC, and such projects as "Shenzhou," "Tiangong," "Beidou," "Tianhe," "Chang'e." Special attention is paid to the review of a variety of Chinese space assets like communication satellites, navigation satellites, meteorological and oceanographic satellites, remote sensing satellites. Also, the national security implications of the the PRC national space program are considered as a security guarantee for China's peaceful development. It's arguing that Chinese strides in advancing space technologies have a direct connection to the fulfillment of "China's Dream" in dimensions of scientific and technological leadership and social-economic prosperity.

Keywords: China's space program, technological development, increasing competitiveness, Chinese Dream, global leadership, national security, scientific leadership

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Introduction

Space exploration and development have both geopolitical and social potential today. China, as one of the most influential countries in the world, has long recognized the need for a confident presence in the vanguard of the few countries that are intellectually and technologically capable of exploring and developing extraterrestrial space. But what are the driving motives for China's participation in this complex and very capital-intensive, resource-intensive, and knowledge-intensive process? We assume, that a whole set of aspirations, such as further growth of welfare, sustainable development, strengthening of Chinese positions in the fields of science and new technologies, diversification of the national economy, active participation and taking even more significant positions in global politics, ensuring national security — in short, everything that conceptually fits into the concept of the "Chinese Dream."

The purpose of this article is to analyze the space program of China, the features of its implementation at different stages of socio-economic transformation of the PRC, with real successes in certain areas of space research, as well as with the near and distant prospects for the development of the Chinese space program. An important task is to understand how the achievement of individual results in the field of space research and development affects the implementation of socio-economic, socio-cultural, and political tasks of the PRC, conceptualized in the "Chinese Dream."

The "Chinese Dream" is expressed in different formulations, due to its polysemantic nature. Summarizing all the many statements on this subject, we can assume that the true realization of this dream will be considered to be the multiple strengthening of China's position in the modern dynamic and the highly competitive world; the growth of Chinese national welfare through successful external and internal cooperation (economic, political, technological); the satisfaction of the growing personal interests of ordinary Chinese while preserving social harmony and national unity; the preservation of China's cultural identity with its active participation in the processes of globalization.

Obviously, for this whole kaleidoscope of such complex and diverse Chinese interests to form the desired picture for the PRC, it is necessary to include it as much as possible in geopolitics, using various tactics. As practice shows, in the 21st century, the role of a successful player in the field of geopolitics is successfully combined with the status of a "space superpower." Such powers need not only to have their space program but also to actively update and develop it. In this study, the author's attempt to analyze the prospects of China in the "space race" through the prism of global scientific and technical leadership will be carried out.

Strategic, scientific and technical aspects of China's space program

In the face of the challenges that 2020 has brought to the world community, the developed countries of the world are forced to take decisive steps to strengthen the innovative component of the economy and modernize development strategies for the near and long term. Among the innovative approaches that are most likely to contribute to the growth of economic well-being and strengthen leadership positions in the global community, China sees the further development of aerospace innovations.

It is no accident that Xi Jinping, at a ceremony attended by taikonauts of the Shenzhou-10 space mission, stressed that they "carried the nation's space dream." In particular, when they were orbiting the Earth in the Tiangong-1 space module, President Xi told them the following: "...The space dream is part of the dream to make China stronger. With the development of

space programs, the Chinese people will take bigger strides to explore further into space" (Xinhua, 2017). This conversation took place in June 2013. Next, we will focus in more detail on how China's national space program is developing.

The launch of the "policy of reform and openness" has significantly contributed to China's progress in the development of space technologies. However, the Foundation for the country's development in this direction was laid earlier. So, in 1956, the Fifth Academy of the Ministry of Defense was created, which was later headed by the scientist Qian Xuesen, who returned from the United States. He created the preconditions for the launch of Chinese satellites. At the same time, at this stage, China was very dependent on extensive cooperation with the Soviet Union, which contributed to the development of Chinese space research and development.

The USSR granted China a license to manufacture the R-2 ballistic missile, which allowed the launch of Project 1059. Technical assistance from the Soviet side contributed to the development of the Dong Feng-2 and Dong Feng-3 ballistic missiles. After testing the Dong Feng-4 rocket in 1970, China developed on its basis and successfully launched its first carrier rocket, Chang Zheng-1, which launched the first Chinese communication satellite, Dong Fang Hong-1. The launch was successfully completed on April 24, 1970, and demonstrated the effectiveness of the PRC in launching space satellites. So the "Chinese space age" opened.

Guided by considerations of national prestige, economic growth, and trying to consolidate the existing technological maturity, China has identified the need to create an orbital constellation of satellites (satellite constellation). Besides, expectations in terms of using space technologies for national security purposes have had an additional impact on strategic decision-makers in the PRC: "Deeply influenced by techno-nationalist ideas, Chinese officials considered technological progress, particularly in the field of space, as means to foster national economic growth, gain international prestige and strengthen the country's military capacities" (Al-Rodhan, 2012: 128). These interests determined the priority choice in China's development of its system of remote sensing, communication and navigation satellites. The Chang Zheng series of liquid-fuel space launch vehicles (CZ-2, CZ-3 and CZ-4) created in the PRC allowed China to create an orbital satellite grouping, through which the functions of navigation, communication, remote sensing of the Earth, collecting meteorological data, and maintaining national security are implemented.

From a technical point of view, having your group of satellites provides a wide range of opportunities for different types of presence in space. A satellite constellation is a group of an average of 30 artificial satellites working together as a system. Unlike a single satellite, their constellation can provide constant global or near-global coverage, so that at least one satellite is "visible" on Earth at any given time (Walker, 1984). Artificial satellites are usually placed on special orbital planes and communicate with globally distributed ground stations. They can also use inter-satellite communication.

China launched experimental communications satellites in 1984, but their widespread production and operation began in 1988. China's initial goal was to intensively introduce this type of satellite for radio, television, and mobile communications. There was a demand to create more advanced space platforms with extensive capabilities for broadcasting and telecommunications satellites of the new (third) generation. In particular, the geosynchronous satellite Dong Fang Hong-4 (DFH-4, 2006-2016) met these technical challenges. Also, it reduced the dependence of the Chinese space sector on other countries. Later, China Aerospace Science and Technology Corporation (CASC) and its state-owned subsidiary, China Satellite Communications, modified the entire DFH-4 satellite series. The most famous

Chinese satellite communication brands, ChinaSat and SinoSat, launched commercial offers for foreign customers, placing satellites in geostationary orbit on the order of other countries.

In the past decade, China has made significant progress in creating satellite systems for fixed, mobile communication and data transmission. The commercialization of this sphere and the entry of the PRC into the international space market contributes to the creation of added value in many civil areas of China, such as education, management, transport, financial and commercial sectors, not to mention the growth of quality in the provision of broadband services and broadcasting technologies (Ma & Soroka, 2020).

Such technological capabilities increase the geopolitical potential and contribute to strengthening security (Al-Rodhan, 2013: 221; Sekerin et al., 2019). "An interplay between outer space security and terrestrial global security" (Al-Rodhan, 2018) is followed. China's expansion of its space potential is also reflected in its leadership positions in world politics: "Over the past two decades, China has risen to become the second-largest economy in the world and impressive military power. The assumption is that China will seek to replace the United States as the hegemon in the international system" (Chau & Kane, 2014: 112).

Communications satellites have paved the way for many satellites of other applications, such as meteorological and navigation satellites. China began developing its weather satellites in the 1970s. The first satellite of the "Fengyun" series was launched into orbit in 1988 and raised the PRC to the status of the third country in the world with a meteorological satellite. Fengyun-1 entered a polar orbit, and Fengyun-2 entered a geosynchronous orbit.

The presence of such satellites in China was not just a matter of prestige. These were achievements that had practical significance for the state, allowing it to solve problems that often the large agricultural sector faces (natural disasters, especially forest fires, droughts, storms, floods). This aspect is even specifically mentioned in the" White paper on China's space activities in 2016" (The State Council, 2016). Currently, the Fengyun-3 weather satellite is equipped with sensors to receive weather data in all weather conditions, which coincides with the interests of civil society in China, and with the benefits of national security. Thus, the weather satellites of the Fengyun series are equipped with high-precision sensors that can be used in the event of threats to national security.

Fengyun-3 (FY-3) is launched into orbit by the Chinese Chang Zheng 4C (CZ-4C) launch vehicle. Individual space technology experts point out that "the satellite structure is based on a separate bay design, combined structure of center supporting cylinder and guest board for service module and propulsion module, and a combined structure of baffle plate and truss. The FY-3 series satellites are designed and developed by the Shanghai Aerospace Administration" (Barbosa, 2013). Chinese meteorological satellites thus make an essential contribution to the national economy, allowing them to mitigate or even prevent the consequences of extreme weather events and prevent the onset of natural disasters. The last of the launched weather satellites are engaged in round-the-clock monitoring of threats such as sand and other storms, showers, thunderstorms, hail.

Navigation satellite systems occupy an equally important place in the Chinese space program. Currently, China is close to completing the deployment of its own Beidou satellite navigation system (BDS, also known as COMPASS), and this achievement will significantly strengthen China's position in the satellite navigation sector. In the international space services market, the Beidou system will become a serious competitor to the American Global Positioning System (GPS), the Russian Global Navigation Satellite System (GLONASS), and the European Galileo satellite navigation system. However, China is also actively involved in the development of the latter, along with South Korea, Israel, and Ukraine.

The official web portal of the Beidou project covers the current state of this navigation system in sufficient detail. In particular, it is specified: "On March 9, 2020, China successfully launched the 54th BDS satellite by a Long March-3B launch vehicle from the Xichang Satellite Launch Center. BDS satellite successfully entered the designated orbit, and will be commissioned after completing the in-orbit test and evaluation. The BeiDou Navigation Satellite System (BDS) has been developed following a three-step development strategy. BDS-3 is only one step away from completion. It is comprised of 30 satellites, containing 24 satellites in Medium Earth Orbit (MEO), three satellites in Inclined Geosynchronous orbit (IGSO) and three satellites in Geostationary Earth Orbit (GEO). The satellite launched during this mission is the 29th constellation satellite" (BeiDou, 2020).

While the experimental Beidou-1 (1994-2007) initially lacked accuracy and reliability, the second-generation system was significantly refined, and subsequently focused on providing positioning, navigation, and synchronization services in the Asia-Pacific region. As the number of China's BDS-3 satellite constellation has reached 29 satellites by 2020 (out of 30 planned), the system now provides China with high-quality global coverage.

The introduction and improvement of satellite navigation systems in China contribute to the implementation of internal tasks, such as providing emergency management and control, navigation, and monitoring of vehicles in Chinese megacities. At the same time, Beidou contributes to the technological support of the Belt and Road Initiative. Beidou navigation satellites will offer location, speed measurement, and synchronization services to foreign customers in the Asia-Pacific region. In the future, the system will cover all countries located along the "Silk Road Economic Belt" and the "21st century Maritime silk road," integrating ground and orbital control systems. Official sources of the PRC emphasize the following: "The Beidou Navigation System is multifunctional. It is widely used in transportation, maritime fisheries, hydrological monitoring, weather forecasting, surveying and mapping, forest fire-prevention, time synchronization of communication, power dispatching, disaster reduction and relief and emergency rescue, influencing all aspects of people's life and production, and injecting new vitality into global economic and social development" (The State Council, 2016).

Remote sensing satellites are considered one of the main areas of China's space program. Their peculiarity is that "remote sensing provides information about an object without making direct physical contact. Thus, remote sensing is used in numerous fields of human activities and studying the Earth. Maps of land cover from thematic mapping can be used to prospect for minerals, detect or monitor land usage, detect invasive vegetation, deforestation, and examine the health of indigenous plants and crops, including entire farming regions or forests" (Ran et al., 2017).

The use of this type of satellite is particularly relevant for urbanized societies. So, "nowadays, cities across the world are spreading into their surrounding landscapes, sucking food, energy, water, and resources from the natural environment and profoundly changing global ecosystems. Urban ecosystems are among the most dramatic manifestations of anthropological impacts. The advantages of remote sensing — such as relatively low cost, large-area coverage, and repetitive observations — and also the growing interest in urban ecosystems have promoted the application of remote sensing in monitoring the urban environment" (Guo et al., 2013). Remote sensing of the Earth by space vehicles equipped with various types of survey equipment greatly facilitates economic tasks, given that "urban land-use patterns are complicated and heterogeneous, especially in China's megacities. For example, many multifunctional land uses are mixed with living and commercial functions, which increases the difficulty of land use identification" (Liu et al., 2017: 1691).

Both electro-optical and radar satellites developed in China can transmit images of the Earth's surface and other geo-information data in real-time. These technologies are in demand in agriculture, exploration, and monitoring of mineral and other natural resources, and forecasting of natural disasters. Electro-optical satellites were launched by China in 1987 (starting with Fanhui Shi Weixing-1).

The Huanzin series of satellites are used for observing sea and land targets in the microwave range, but mainly for observing the environment. These satellites use SAR (synthetic-aperture radar), which allows you to obtain radar images of the Earth's surface and objects located on it, regardless of weather conditions and the level of natural illumination of the area with detail comparable to aerial photographs. This series of satellites is a useful tool for monitoring potential targets over vast territories, thus strengthening China's position in the Pacific.

Haiyang Oceanographic satellites (HY), along with Shiyan topographic satellites, are designed to support marine operations, promote fishing, and explore the sea and ocean floor. Together, the Haiyang, Shiyan, Gaofen, Yaogan, and Tianhui satellite series allow China to conduct space mapping, land, ocean, and atmosphere observations, with high and low resolution, at the national and global levels.

From space exploration to global technological leadership

China's creation in the distant 1970s of the Long March series launch vehicle, also known as Chang Zheng (CZ), based on the Dong Feng-4 ballistic missile, laid the technological prerequisites for China to become the world's third country with human spaceflight technologies almost three decades later. On this path, Chinese society, in particular, scientists and politicians, had to overcome many obstacles of a financial-economic, scientific-technical, and socio-political nature. As it is rightly noted, these obstacles are related to the fact that "human spaceflight is technically very demanding, and this is indeed one of the reasons why it is so expensive. However, for this very reason, engaging in human space activities must necessarily act as a stimulus for employment, skill development, and technical innovation in the participating industries. This expansion of technical capabilities is likely to find applications in other areas of the wider economy. Note that this would be true even if the research conducted in space did not itself yield economic benefits, whereas, in fact, some industrially beneficial applications of microgravity research can already be foreseen" (Crawford, 2005: 256).

China's first space program aimed at creating a manned mission was Shuguang (also known as Project 714), which was implemented since the late 1960s. It was to be replaced by the Fanhui Shi Weixing (FSW, literally "returnable satellite") program. Although the project-714 "Shuguang "was discontinued before reaching a practical result, however, the CZ-2A carrier rocket was brought to operation, and large three-ton FSW satellites with reentry vehicles were created on the basis of developments on the Shuguang ship. The FSW program worked in the period 1974-2006, putting into space (and 22 times successfully returning back) satellites for various purposes. Most of the FSW satellites were intended for conducting photographic remote sensing of the Earth. Unfortunately, the project to implement manned flights in China, under Fanhui Shi Weixing, was not successful, and this part of the program was closed around 1979. Nevertheless, an important result of the second Chinese manned program was the overcoming of an important technological milestone in this complex evolutionary process by the Chinese space industry: "the conception of "Evolution" comes from the field of biology, and usually it is used to describe the constitution and succession of

community. However, the spacecraft dynamics system also shows behaviors similar to those found in biology" (Yang & Liu, 2019: 128).

A new manned space program was proposed in 1986 by the Chinese Academy of Sciences as Project 863 (Astronautics plan 863-2). The project involved the creation of a manned spacecraft (Project 863-204) designed to deliver taikonaut crews to the space station (Project 863-205). As a result, Project 863 was transformed into Project 921, starting in 1992. Since then, the third manned space flight program of the PRC — Shenzhou has been developed (until 1999, it was called Project 921-1), within which as of today, 11 missions have been completed, including the flight of the first Chinese cosmonaut (2003, Shenzhou-5 mission); the first taikonaut spacewalk (2008, Shenzhou-7 mission); the expedition of the first female taikonaut and the first docking with the Tiangong-1 orbital station (2012, Shenzhou-9 mission); the docking with the Tiangong-2 space laboratory orbiting station, with the participation of the crew (2016, Shenzhou — 11 mission).

Over the past few years, as part of project 921-2 (creating a multi-module manned space station similar to the ISS, only smaller), China has been building the Tianhe (OI, or core of the CCM cabin module)-the basic 20-ton module of the future Chinese space station, designed for the long-term stay of three taikonauts. Shen 2021 Shen Shenzhou is the 12th, but the last one is still on Earth. "The main Tianhe module and two experimental capsules, wentian and mengtian, responsible for the assembly and construction of the basic configuration of the space station in orbit, will be launched" (Yun, 2020).

The manned space program, whether in China or any other country, does not bring a quick and immediate socio-economic effect. Unlike launching civilian satellites on a commercial basis. The value of manned missions is expressed in other ways: in the development of engineering and high technologies at the expense of the aerospace sector, increasing international prestige and recognition of the country's status as a "space superpower" with a unique scientific and technical potential. These characteristics help to legitimize leadership positions on a global scale.

The implementation of the Tiangong program will make China the owner of a national orbital station for a permanent presence in space in the coming years. The strengthening of leadership positions and independence in space exploration has become an incentive for China to create its own space station in orbit. At the same time, the life of the existing International Space Station is coming to an end (14 participating countries have agreed to operate the ISS through 2024, and an extension of the operation period to 2028-2030 as a maximum is considered). Therefore, it is possible that the multi-module orbital station currently being created in China for a specified period (from the mid-late 2020s) may make China the only owner of a multi-purpose space research complex in earth orbit in the world. In any case, one necessary technical condition for launching the Tianhe base module into low-earth orbit has already been achieved: in May 2020, the test of the upgraded long March-5B (CZ-5B) heavy launch vehicle was successful.

One of the most impressive recent achievements of Chinese cosmonautics is the sending of robotic Chang'e missions to the Moon. The lunar research program began with the launch of two vehicles into selenocentric orbit in 2007 and 2010, to prepare for a soft landing of spacecraft on the surface of the Moon and delivery of lunar rovers. In 2013, Chang'e-3 (BK-3), a Chinese automatic interplanetary station for the study of the Moon and outer space, made the first soft landing on the visible side of the Moon since 1976 (the last time this was done by the Soviet automatic interplanetary station "Luna-24"). Mission, THUS, became the third power in history, after the USSR and the United States, to make a soft landing

on the Moon (Krichevsky & Bagrov, 2019). "The CE-3 mission also created an excellent opportunity to observe the lander in the absolute sense, that is, with the standard geodetic VLBI (very long baseline interferometry). This effort was implemented within OCEL by observing the Chang'e-3 lander using the VLBI program" (Klopotek et al., 2019: 1-2).

January 3, 2019, for the first time in the history of mankind, made a soft landing on the backside of the Moon launched by China AMS "Chang' e 4", consisting of a stationary lunar station, carrying the lunar Rover "Yutu-2". The main difficulty in carrying out this expedition was the CE-4 communication technology with the earth control center. On the other side of the Moon, direct communication with the Earth is not possible, since the Moon blocks any signals. Communication must pass through a communications relay satellite located in a location that would have a clear "view" of both the lunar landing site and the Earth itself. As part of the lunar exploration program, specifically for the Chang'e-4 mission, CNSA launched the Queqiao relay satellite at the L2 Lagrange point in May 2018.

Some scientific publications explain why the study of the reverse side of the Moon is so interesting for modern cosmology and basic science in general. First of all, "the lunar far-side is a virgin land and a unique scientific platform on which no humans or robots have ever landed. The Moon preserves the earliest rocks and craters after the formation of the Earth-Moon system, which could not be found on the Earth's surface, and the oldest crust locates on the lunar far-side. Hence high-precision in-situ mineralogical and geochemical data of the far-side could make great contributions to the formation and evolution of lunar primordial crust and the evolution theory of terrestrial planets" (Wang & Liu, 2016: 678).

Secondly, the testing of the created innovative technology on the spot was no less important for the Chinese space industry. After all, no one before among the space powers has sent missions to the other side of the Moon: "Similar to Chang'E-3 (CE-3), three types of sensors were employed by CE-4, including a laser ranging sensor, a microwave ranging and velocimeter sensor, and an optical imaging sensor, and a laser imaging sensor" (Li Shuang et al., 2016).

Thus, the active development of near-earth space, despite its very high cost, can ultimately further contribute to the socio-economic development of China. The value orientations of Chinese society play an important role in this process, which was partially explored in our previous publications (Stovpets, 2019a; Stovpets, 2019b; Svyrydenko & Stovpets, 2020).

Contribution of the national space program of the PRC into the support of national security

China considers the strengthening of national security, including through the continuous modernization of the military space forces (PLA Air Force), as a guarantee for the continuation of its peaceful development and the realization of the "Chinese Dream." The fact is that military conflicts taking place in the modern world demonstrate the successful use of space-based surveillance tools. The experience of conflicts has finally convinced China of the need to develop national security tools with the active integration of space technologies.

The National Security Law defines space components as one of the crucial segments of national security and defense capability in the current information technology realities. Related to this is the need to develop concomitant factors: "The state shall strengthen the building of capability of independent innovation, accelerate the development of independent and controllable strategic new and high technologies and core technologies in important fields, strengthen the utilization and protection of intellectual property rights, and the building of science and technology secrecy capability, and guarantee the security of major technologies and projects" (NSL, 2015: article 24).

For most Chinese and international military researchers, it is evident that future conflicts go beyond the traditional land, sea, and air dimensions. Any local conflicts, as well as the peaceful life of the world community, will inevitably take place in the conditions of informatization and digitalization. The ability to collect, analyze, transmit, and use information is becoming an effective tool for ensuring national security, and the level of development of space technologies plays a unique role in it. In this context, we agree with the following thesis: "Certain states are currently pursuing the development of more advanced missile defense capabilities that will employ space-based interceptor components to compliment sea- and ground-based missile defense systems as part of a layered defense designed to intercept missiles at three separate points of their flight trajectory. The use of this military space technology is purported to be a stabilizing force in international relations" (Sariak, 2017: 56).

Conclusions

China, as shown in this study, is committed to developing its space program in all possible directions. We are talking about: launching satellites of various purposes for civil, military and combined tasks of the PRC itself; launching satellites for other countries into space (on a commercial basis); implementing a program of controlled space flights; working on the creation of its own multi-module long-term orbital station; serious success in the study of extraterrestrial spaces (in particular, the Lunar program, with the prospect of sending taikonauts to the Moon); issues of strengthening the level of national security of the PRC through the development of space infrastructure and advanced aerospace technologies. At the same time, China has repeatedly stressed on the peaceful orientation of its space research and its readiness for broad international cooperation with both recognized space powers and third countries.

China demonstrates leadership in the quantity and quality of space technologies. And if at the beginning of this path, the success of the development of the Chinese space program largely depended on various foreign partners, today's China focuses on its strength, intensively increasing its innovative potential in this area. However, it also continues to strive for productive and mutually beneficial scientific and technical cooperation. As the space sector develops, China is making progress in implementing the principles of an innovative economy. The prospect of China's monetization of various segments of the national space program (first of all, the use of the future orbital space station; expansion of commercial launches for foreign public and private customers; introduction of the Chinese global navigation system), gives grounds to assert China's leadership potential in the post-industrial era. After all, we are talking about occupying one of the critical niches in the global technology market, where only a few countries can compete today.

China considers achievements in space exploration and development as a vital competitive advantage that carries both image and socio-economic dividends. After all, the further application of the implemented space projects becomes an accelerator for the technological, economic, and social development of the PRC. The full implementation of the" Chinese Dream" implies continuous technological development, raising the standard of living of the population, and expanding international cooperation. Space projects play an essential role in the implementation of these aspects of this national strategy, and their role will become more significant over time.

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