KUANG-HO YEH[*]

GUIHUA NI[*]

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CHINA-PAKISTAN SPACE COOPERATION: PATH, MOTIVATION AND THE FUTURE[*]

Abstract: *After the founding of the People's Republic of China, friendly bilateral relations between China and Pakistan have become increasingly close in various fields following China's peaceful rise. The space cooperation that started after the end of the Cold War is a sign of the gradual progress of the relationship between the two countries to the current all-weather strategic cooperative partnership. With China's assistance, Pakistan has achieved significant milestones in the space field. Pakistan is also a key node in China's strategy to expand international space cooperation. After the 2010s, China-Pakistan space cooperation was integrated with the construction of the Space Silk Road and the China-Pakistan Economic Corridor under the framework of the Belt and Road Initiative, becoming a model for space cooperation specifically promoting the social and economic development of developing countries. This paper outlines the complete picture of China-Pakistan space cooperation under the evolutionary logic and chronological context of "ideological-materialization" two-way mutual construction, so as to reasonably predict the prospects of China-Pakistan space cooperation.*

Keywords: *China-Pakistan Space Cooperation, Space Diplomacy, Space Silk Road, Asia-Pacific Space Cooperation Organization.*

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[*] PhD candidate in International Relations: Institute of International Relations, Nanjing University, China. Research interests: Space policy and politics, international security, and regional governance. ry1207@gmail.com

[*] PhD in International Relations: Institute of International Relations, Nanjing University, China. Research interests: Interaction between technology and international power structure, which belongs to the major of international political economy. dg1913005@smail.nju.edu.cn

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Introduction

This article analyzes the space cooperation between China and Pakistan and aims to answer the following research questions: First, what are the background and framework of China-Pakistan space cooperation? Second, what are the motivations and benefits for each country behind the cooperation? Third, what are the negative issues and positive opportunities that will be faced in the cooperation, and how will the two countries respond and continue to move forward? Current Chinese academic research on China-Pakistan relations focuses on geopolitical competition, regional cooperation, trade, and international aid, with less attention given to cooperation in space, while some Western studies have an ideological bias that makes the perspective and evaluation unobjective. In view of the above, the following will expound the background and implementation of China-Pakistan space cooperation systematically from the empirical evidence and analyze it in depth from the theoretical perspective to explore the internal driving forces and external standpoints followed in the cooperation process, as China and Pakistan have disparate levels of space development. Finally, reviewing the challenges and opportunities associated with China-Pakistan space cooperation.

Overview of the process and achievements of Pakistan's space history

Pakistan’s space development can be divided into the embryonic period from 1961 to 1970, the stagnant period from 1971 to 1990, the revival period from 1991 to 2010, and the stable period from 2011 to date (Mehdi and Su 2019, 175-180; Atif 2020, 48-59).

The embryonic period (1961~1970):

The Space and Upper Atmosphere Research Commission (SUPARCO), established in 1961, made Pakistan the first South Asian country to launch the space program. Initially focused on the peaceful applications of space technology for national advancement (SUPARCO, 2022), SUPARCO collaborated with NASA to launch the Rehbar-1 in 1962, making Pakistan the third Asian country to launch rockets after Israel and Japan (Lele 2013, 43-58). During the same period, the US

started the Apollo program and required atmospheric data on the Arabian Sea. Pakistan, being located in the Indian Ocean region, provided NASA with meteorological information collected by the Rehbar rockets, which aided the first manned lunar mission of Apollo 11 in 1969 (Mehdi and Su 2019, 176-177).

The stagnant period (1971-1990):

In the 1970s, Pakistan shifted its focus to developing nuclear weapons due to geopolitical hostility with India. The space program was disrupted because of domestic economic difficulties and political instability. The authorities transferred the rocket experience to missile development, triggering sanctions from the US in the 1980s. By the 1990s, lack of financial resources caused SUPARCO's space program to be ineffective (Awan et al. 2018, 132-133), resulting in a development hiatus over two decades between the first rocket launch in the 1960s and the launch of the first satellite in the 1990s.

The revival period (1991~2010):

US sanctions in the 1980s created an opportunity for space cooperation between Pakistan and China. China provided technological assistance, enabling SUPARCO to resume operations in the 1990s. Notable Projects included the BADR and PakSat satellite series. BADR-1, an experimental observation satellite, was launched on the Shenzhou-2 rocket and completed a one-month mission cycle. In 2001, BADR-2, equipped with Earth photography instruments, was launched by the Russian Zenith-2 rocket (Ahsan ed. 2019, 41-43), and PakSat-1 entered the frequency orbit to provide domestic communication services. Pakistan became one of the few countries with communications satellites in orbit at the time (Atif 2020, 51). Ten years later, PakSat-1R was launched, replacing PakSat-1 and optimizing and expanding the service scope.

The stable period (2011-):

"Pakistan Space Vision 2040" document is the first mid- and long-term space development plan issued in 2011 that covers military and civil aspects. The Vision aims to make Pakistan a recognized "space-faring nation" by focusing on space application technologies based on military strategic purposes and establishing a

command and control system through the deployment of military satellite systems for intelligence and early warning functions to consolidate existing defense architecture (Awan ed. 2018, 133). In the civil domain, the Vision works on improving the quality of life of Pakistanis through space activities and satellite development of the "full spectrum of space technology". The core action of the Vision is to launch six LEO satellites of the PRSS series and five Geostationary Orbit (GEO) satellites of the new-generation PakSat series between 2011 and 2040 (Ahsan ed. 2019, 41-42). In 2018, SUPARCO launched remote sensing satellites PRSS-1 and PakTES-1A, the latter of which was designed and developed by SUPARCO, symbolizing Pakistan's capability to develop indigenous satellites. In 2014, Pakistan became the first country to switch its domestic satellite navigation system from the US Global Positioning System (GPS) to the Chinese Beidou System (BDS) (Mehdi and Su 2019, 178). The BDS provides Pakistan with a cross-domain geographic information network for transportation management, urban planning, environmental monitoring, and disaster monitoring, highlighting the deepening of China-Pakistan space cooperation.

Concept, positions and consensus of China-Pakistan space cooperation

"Global Commons" refers to the territory and resources that are not subject to national sovereignty but belong to the common heritage of mankind, including the high seas and international seabed, international airspace, the polar, cyberspace, and space (Ren 2014, 120-126). The spatial domain of space refers to the moon and Earth orbits where satellites operate, and space resources are the materials available for human use, such as solar energy and planetary minerals. The Global Commons has attributes of "non-excludability" and "competitiveness" (Han 2018, 2). The former means Global Commons is open to all actors. The exploitation and utilization conducted by any individual, organization, or country shall not impede the equal behavior of others. However, the resource distributions of Global Commons are uneven, resulting in a competitive orientation. Specific actors seize the tools, and accessibility often owns the advantage. The contradiction between non-exclusivity and competitiveness is the logic of cooperation. In space, the Outer Space Treaty,

known as "the Space Constitution", stipulates free access for all countries. However, the high cost of satellite launches and operations limits space activities to a few states with technical and economic strength, forming a hierarchy on a material basis (Way 2018, 7-9). Therefore, international cooperation becomes a strategic choice for all countries, whether they are traditional or emerging space powers.

Launching space cooperation—China's motivations and positions

Brain Harvey categorized space powers based on human spaceflight technology thresholds, with the United States, Russia, and China as space superpowers (Harvey ed. 2010, 543-545). The classification shows the technical characteristics of different periods and the dynamic identity changes of state actors. China began its space program in the 1950s. Rapid economic growth since the 1980s has been reflected in high-speed space development in rockets, satellites, manned spaceflight, deep space exploration, missile defense, and manufacturing. In 2003, the Shenzhou V completed the first manned space mission, making China the world's third space superpower.

The motivations behind the transnational cooperation of space powers can be explained by the economic statecraft theory of political economy. David A. Baldwin defines "economic statecraft" as the use of various economic tools by state actors to promote political, diplomatic, or security goals (Aggarwal and Reddie 2020, 4). There are three elements: The policy tools that generate influence, such as investment, foreign aid, and financial control; the field of exerting influence, which is international society; and the mode of influence, by changing cognitions of the target object, such as attitudes and expected behaviors (Baldwin 2020, 31). Michael Mastanduno introduced "structural linkage"—the use of economic incentive to seek desired configurations of interests with the target countries—to define the interaction between "actors" and "recipients" of economic statecraft. For the actor country, the structural linkage is unconditional and will not change because of the sudden behavior of the recipient country. The deepening of economic interdependence leads to the increasing influence of the actor country and consolidates the bilateral relationship (Mastanduno 1999, 304-309). Foreign aid is the most common policy choice among economic statecrafts, as seen in the Marshall Plan and the Point Four Program after

World War II, which strengthened the US hegemony by earning the confidence of global countries through modernization (Roberts 2021, 269-271). The economic statecraft of China to pursue diplomatic goals has occurred in the context of South-South cooperation by providing foreign aid to developing countries. Paul Papayoanou points out that, in addition to building increasingly solid networks with target countries, economic statecraft has invisibly reduced the perception of Western countries hyping up China as a rising hegemonic threat (Papayoanou 2019, 119).

Stephen Whiting introduced Baldwin's theory into the theoretical analysis of the space domain and proposed the "Space Diplomacy Model" from the perspective of national interests, where space powers use advantages to pursue political and diplomatic goals (Whiting 2002, 54-57). Space assets and capabilities are similar to economic statecraft in traditional diplomacy. Whiting listed seven paths to build the model, with increasing operational influence: prestige, technology partnerships, access to space services, legal precedent, objective information, subject presence, and threat of punishment (Whiting 2003, 60-74). This article focuses on the integrated dimensions of "prestige and presence", "technological partnerships and access to space services", and "objective information", as the compositions of the Chinese Space Diplomacy Model, to analyze the motivation and positions of space cooperation.

1. Prestige and presence

Prestige is rooted in the innovative nature of space technology. He Qisong pointed out that space exploration capability is a public display of strength, wealth, and vitality and is also a source of national pride and confidence (He 2008, 9). Steven Lamakis believes that space programs are a measurement of national prestige and a key weight in the comprehensive power scale among world countries (Lambakis 2002, 55). Presence and prestige are two sides of the same coin in the image of a space power. Presence refers to the material properties of space assets and their proximity to specific space targets. The sense of presence from external space assets creates space awareness and influences the behaviors of space actors. The Space Diplomacy Model suggests actor countries demonstrate their commitment to space

development through the sustained accumulation of prestige and presence, strengthening the credibility of space cooperation.

2. Technology partnerships and access to space services

Technology partnership refers to the actor country establishing a cooperation relationship by granting key space technologies to the recipient country and guiding the country to adopt consensual behaviors. It also means that, despite the premise of unequal space capabilities, cooperating countries can contribute to common goals. Space superpowers challenge cutting-edge space missions, disseminate the industrial chain, and assist partner countries in cultivating space talents. An example of this is the International Space Station (ISS), the US-funded remote manipulator systems developed by Canada, and the Spacelab operated by the European Space Agency, which not only shared the costs but also strengthened the interdependence (Whiting 2002, 63). The most direct impact of the proliferation of space technology is that space superpowers provide cheap or free space services similar to foreign aid, as most of the recipients are developing countries. Space superpowers do not expect relative compensation but rather improve the people's quality of life in developing countries, thereby shaping a positive image (Whiting 2002, 64). Cheng Qun argues that as the leader of developing countries in the space field, China leads other developing countries towards space through space diplomacy, sharing the economic and social benefits brought by space services, which has become the best example of South-South cooperation (Cheng and Fu 2013, 77-79).

3. Objective information

Space vehicles can operate in space over any country according to international space jurisprudence, allowing satellites to gather high-precision information on Earth through photography and radar echoes (Whiting 2003, 67-68). Obtaining information can help countries learn about their own and other countries' situations and predict scenarios. The GPS, once a US military strategic resource, has become an international public good for accurate positioning, navigation, and timing (PNT) services (Johnson ed. 1998, 14-15).

Enhancing international prestige is regarded as the main driving force for

China's space development (Cunningham 2009, 73-74). Since the 2010s, China has made significant breakthroughs and established a renowned objective presence, including the Chang'e-4 probe, which landed on the back side of the moon in 2019, and the Tianwen-1 lander, which made China the second country to arrive on Mars in 2020. These achievements reveal that China's space program has surpassed traditional ideology and looks to explore sustainable resources across planets and contribute to the global community. In 2022, the Tiangong space station completed the connection with the Shenzhou 14 spacecraft and the Wentian experiment module, becoming the second long-term resident base in space. The technology partnership is indispensable behind this milestone, with collaborations from agencies such as the European Space Agency and Roscosmos. In 2019, nine research projects from 17 countries on the Tiangong station were released. The Chinese space station has become the core platform for frontier research and technology exchange (Lu 2021). Besides the pioneer-oriented Tiangong plan, China has engaged in diverse cooperation in satellite launches and infrastructure with developing countries. The Beidou system, China's independently developed and operated global satellite navigation system, has launched a wide range of information services in over 120 countries and has created a new model of foreign aid—the "high-tech foreign aid", which has significant implications for enhancing China's international influence (Hu 2015, 7-13).

Seeking space cooperation—Pakistan's motivations and positions

Pakistan's space development is characterized by close ties with space superpowers. James Oberg proposed two constraints that most countries face in their space development processes (Oberg 1999, 136). The economic constraint means that high sunk costs are required for space programs, which creates a crowding-out effect of fiscal resources with immediate livelihood projects. The technical constraint includes access to technology—space exploration involves cutting-edge technologies and high-end human resources, which the domestic side is difficult to feed. Understanding of technology—it is a common fact that education and civil society awareness are relatively low in developing countries. Space programs are difficult to

achieve in a short period of time, leading to a lack of support from a large number of disadvantaged groups. Obsolescence of technology—space development belongs to a technology-intensive growth model; early-stage research may be replaced by other countries' innovations, making it challenging to stabilize space projects and exposing them to huge financial risk. Oberg's argument described the multiple bottlenecks in Pakistan. Conversely, these challenges become the roots of seeking international space cooperation. Agnieszka Lukaszczyk argues that developing countries invest limited resources in space programs, focusing on the well-being of their people and gaining space power recognition (Lukaszczyk 2011). The foundation of Pakistan's space program was laid with initial US assistance and comprehensive cooperation with China. Pakistan also became a member of the "Five Conventions" of the international space cooperation and normative system. The dynamic mechanism and path consist of three domains: technology, economy, and diplomacy.

1. Technology domain

For developing countries, technology transfer is the most important feature of international space cooperation, which can be divided into hardware and software. The hardware includes the transnational transfer of satellites and space infrastructure (Ansdell ed. 2011). For example, the Chinese CGWIC has become the major source of satellites for Asian and African countries in recent years. The software focuses on professional training. The space field brings together interdisciplinary knowledge, and international cooperation helps to cultivate research talents and labor quality (Azriel 2017, 5). The United Nations Asia-Pacific Regional Space Science and Technology Education Center, composed of 10 developing countries, including China and Pakistan, provides professionals and students from member states with workshops, short courses, and formal degree education (UNOOSA 2014).

2. Economic domain

Developing countries enhance comprehensive space capabilities through transnational commercial activities. Market competition and innovation trends stimulate local technology, and the spillover effect drives advancement in upstream and downstream industries. Countries with economic strength exercise their "buying

power"—purchase basic space services directly from advanced countries or even intelligence, surveillance, and reconnaissance services by military satellites of space superpowers (Klein 2012, 115-116). For countries with a lagging economy, buying power is converted into direct technical assistance from international organizations and other space powers (Iyengar 2021, 24-34). The UNOOSA "Space for Sustainable Development Goals" (Space4SDGs) initiative focuses on popularized space application projects contributing to the UN 2030 global sustainable development agenda (Baumgart 2021, 2-4).

3. Diplomatic domain

Developing countries use diplomatic means such as proposing initiatives and participating in the negotiation of international space norms or agglomerating influence through collective cooperation mechanisms to ensure access to space (Dennerley 2016, 30). Under the impetus of developing countries, the UNOOSA launched the Human Space Technology Initiative (HSTI) in 2010, aiming to establish an international exchange platform for space technology and information, promote cooperation among space and non-space countries, and enable more countries to participate in space exploration and manned space activities (Ochiai ed. 2014, 584-587). The accumulation of national prestige and presence in space is the deeper appeal behind the diplomatic activities, providing developing countries with higher mobility and more choices in dealing with space activities. For example, the number of communication satellites in Earth's orbit increases the discourse power of state actors striving for radio frequency or orbital positions within the authority of the International Telecommunication Union (Klien 2012, 114-115).

For Pakistan, China-Pakistan space cooperation is vital for space development by balancing technology, economy, and diplomacy. For China, there is an actual need with the in-depth advancement of the Belt and Road Initiative (BRI), and the construction of the "Space Silk Road" has become the consensus of countries in the region to fulfill the demand for interconnection. It is also a key factor for both countries to accelerate the expansion of space cooperation.

Content and characteristics of China-Pakistan space cooperation

The historical background and implementation phases

China-Pakistan space cooperation began in the 1990s and has continuously progressed in breadth and depth over time, divided into four stages. During the initial stage (1991-2006), the Ministry of Aerospace Industry and SUPARCO signed the "Cooperation Agreement on the Peaceful Utilization of Aerospace Science and Technology" in 1991, positioning future cooperation with the goal of promoting peaceful use of space under the principle of equality and mutual benefit. The most representative progress in this period was the establishment of the Asia-Pacific Space Cooperation Organization (APSCO). In 1992, China, Thailand, and Pakistan initiated the Multilateral Cooperation on Space Technology Applications Initiative in the Asia Pacific Region (AP-MCSTA), the precursor of APSCO. APSCO was officially founded in 2005, becoming the first international space organization led by China. As a founding member, Pakistan participated in the Small Multi-Mission Satellite (SMMS) program of the organization (Siddiqi 2010, 132-133). The second stage (2007-2011) was a phase of substantial software and hardware input from China. The two countries signed the "Framework Agreement on Deepening Cooperation in Space Science and Technology" in 2007 to carry out cooperation in communication satellites. The PakSat-1R communication satellite project started with China responsible for the design, manufacture, and launch tasks, which was also the first satellite in orbit delivery in Asia. In 2011, PakSat-1R was transferred to SUPARCO in geostationary orbit by the Long March 3B rocket, with an expected lifespan of 15 years. Its primary mission was to provide basic communication services for Pakistan, South Asia, Central Asia, and East Africa. During the development of PakSat-1R, China provided Pakistan with loans totaling over 300 million RMB (Ali 2011).

The third stage (2012-2021) of space cooperation was an all-round technology promotion period. The "2012-2020 Space Cooperation Outline" was signed in 2012 to focus on civil space projects. China developed the PRSS-1 remote sensing satellite for Pakistan. In 2019, the two countries signed the "Cooperation Agreement on Manned Space Flight Activities". A Joint Committee on Manned Space Cooperation was set

up to conduct the subsequent technology testing and astronaut training (SpaceWatch, 2019). The ultimate goal is to send Pakistani astronauts into space in 2022. The fourth stage (2021–present) aims to deepen the cooperation, with the "China's Space Program: A 2021 Perspective" white paper proposing to jointly carry out lunar and deep space exploration as well as the development of a new generation of communication satellites. Pakistan has also been allowed to enter the Tiangong space station, symbolizing that China-Pakistan space cooperation has moved from single-way technology transfer to cooperative exploration of cutting-edge research.

The strategic foundation and innovative path

Space technology is one of the frontier fields that China has rapidly developed in the past few decades. The underlying motivation for China's space development is to combine various space projects from a micro perspective with the national diplomatic strategy at the macro level. This has created a multidimensional space cooperation paradigm integrating international space cooperation and traditional regional governance. Through the projection of space assets and the deployment of corresponding space capabilities, via the functional connection with the expansion of livelihood infrastructure projects on Earth, establishing an integrated development framework for benefit transfer and mutual construction in a "trans-earth" scope.

The innovative paradigm is practiced in the three-dimensional engineering of the BRI—the Space Silk Road Initiative originated in 2014 (SpaceChina, 2014). The Space Silk Road aims to enhance comprehensive space capabilities in the BRI region, support the space industries of countries along the route, and coordinate multilateral space cooperation strategies. Ajey Lele pointed out that "connectivity" is the core element of the BRI and is reflected in China's strategic actions in becoming the provider of space services. Any construction plan along the route needs to rely on satellite systems, creating demand for the Space Silk Road (Lele and Roy 2019, 26-28). He Qisong argues that the Space Silk Road has built a multi-dimensional cooperation system of "sea, land, air, cyber, and space", promoting the interconnectivity of the BRI route, facilitating resource exploration, the exchange of cargo and personnel, and strengthening the monitoring and protection of the

ecological environment, achieving mutual trust between China and countries along the route (He 2016, 76). Ahmad Khan views the Space Silk Road as a way for the Chinese space industry to break the embargo imposed through the International Traffic in Arms Regulations (ITAR). China projects its space power externally to carry out bilateral and multilateral cooperation through the Space Silk Road. Space competition between superpowers under the ITAR mechanism has shaped their respective technology applications and standardizations. At the global level, two major space partner groups, the BRI countries and the Western countries, have been formed (Khan 2021, 3).

The Space Silk Road entered the official discourse in the "China's Space Program: A 2016 Perspective" white paper. The white paper proposed specific development plans, including the construction of the "Space Information Corridor, using satellite systems to build a space service supply-demand ecosystem covering the BRI route and assisting countries to develop their own technology to provide necessary support for economic activities. The evolving Beidou system constitutes the core component of the Space Silk Road. The system completed regional coverage of China and the Asia-Pacific in 2014. In 2020, after the satellite group finished the constellations deployment, it realized the global PNT service. The current third-generation system consists of three geostationary orbit satellites (covering China), three inclined geosynchronous orbit satellites (covering most of Asia), and 24 medium-Earth orbit satellites (covering the world), with total coverage of more than 50 countries and 3 billion audiences (Mujtaba and Chohan 2021, 17-18).

Pakistan has received space technology from China since the 1990s. As an important participant in the BRI and the first international user of the Beidou system, Pakistan has experienced different socio-economic benefits from both China's general foreign aid and space diplomacy. The synergistic effect is reflected in the flagship project in the BRI—the China-Pakistan Economic Corridor (CPEC), of which Pakistan is a development axis and a geographical hub. CPEC was officially launched in 2015 after leaders of the two countries signed memoranda of understanding (MoU) totaling US$46 billion. China plans to invest in the construction of the Gwadar Port

and the four key areas of energy, transportation, infrastructure, and industrial cooperation as a "1+4" cooperation layout. In the space field, the Space Silk Road and Pakistan's space programs are complemented and converged into the overall plan of the CPEC, such as the PRSS-1 and PakTES-1A satellites, which are part of the CPEC construction plan and aim to provide remote sensing information to a series of CPEC infrastructure projects and monitor the environmental impacts (Khan 2021, 5). A national space center capable of manufacturing, testing, and operating various types of satellites is also included in the CPEC projects (Space Watch Asia Pacific 2018).

The direct impact of the Space Silk Road on the internal side of Pakistan is the improvement of technological level and industrial productivity in the space sector, nurturing an indigenous R&D environment while lowering investment costs and risks. Usman W. Chohan argues that the impact of the Space Silk Road is significantly reflected in the third sector of the economy. Agriculture is Pakistan's economic pillar. Through the satellite data brought by the Space Silk Road, live scenes of crop growth, groundwater levels, and climate changes can be precisely monitored, helping predict crop yields and preventing natural disasters. The Space Silk Road has also boosted the development of Pakistan's information and communication technology (ICT). The popularization of the internet and mobile phones has created new market opportunities. More importantly, ICT plays a key role in connecting information between vast, remote areas and mainstream urban society. Furthermore, the Space Silk Road has promoted the upgrading of science, technology, engineering, and mathematics (STEM) education, leading to scientific research output (Mujtaba and Chohan 2021, 19-20).

Issues and challenges faced by China-Pakistan space cooperation

Issues on military and security

The friendship between China and Pakistan has led to mutually beneficial achievements and reflected their commitment to maintain the stability of the South Asian geopolitical landscape based on their strategic response to the common national security threat of India. India has always considered China its main strategic

competitor due to long-standing border disputes. In the space field, India has regarded China as its target to surpass. Both countries have positioned their space programs as important manifestations of national soft and hard power and have continued to compete at the frontier of technology. However, China is far ahead of India in the development of core technologies (Rajagopalan 2020). Although India's growing space capabilities make it difficult to surpass China in a short period of time, they have greatly widened the development gap between itself and Pakistan, especially in the military and security fields directly affected by space technology. As the two countries became nuclear states successively, India further implemented the space militarization that is complementary to nuclear weapon development. The Command, Control, Communication, Computers, Information, Intelligence, Surveillance, and Reconnaissance (C4ISR) capabilities established through satellite systems pose a serious security threat to Pakistan. The C4ISR system enables India to grasp real-time information on the location of Pakistan's nuclear weapons, missile bases, and the deployment of conventional forces. With India's continuous launch of military satellites and expansion of monitoring coverage and accuracy, Pakistan's political bottom line of maintaining "credible minimum nuclear deterrence" capabilities has been weakened (Hussain and Ahmed 2019, 69-73). Thus, besides accelerating more satellite launch plans under China-Pakistan space cooperation, Pakistan is forced to invest more resources in space-related military capabilities such as ballistic missile defense systems and military satellite communication systems, directly increasing its path-dependency on China.

Pakistan and China began cooperation in the missile field in the 1990s. China has continuously exported multiple ballistic missiles and related technologies to Pakistan. Remote sensing satellites such as the PRSS developed under the Space Silk Road have military and civilian dual uses. Pakistan uses these satellites to monitor border movements, prevent the infiltration of domestic rebels and foreign agents, and provide further feedback on the function of its domestic missile system. The Beidou system projects a key force in Pakistan's defense, guiding its own missiles, assisting the air defense system to detect incoming missile trajectories and intercept those in

time, and transmitting battlefield information to catch the movements of the Indian army in possible war scenarios, thereby reducing the military threat to some extent (Goel 2009). Samran Ali argues that the most effective tactical approach for India to completely suppress Pakistan's defense capabilities would be to use anti-satellite (ASAT) weapons to attack the Beidou satellite constellation, but rashly provoking a military conflict with China is definitely not a rational choice for India (Ali 2022). Khan believes that the development of space technology and the geopolitical games among China, India, and Pakistan have formed a "space security trilemma" beyond the Earth's surface (Khan 2019, 17-18), which is a long-term risk challenge but also a major demand driver for China-Pakistan space cooperation.

Challenges on international politics

The steady development of China-Pakistan space cooperation has aroused covetousness from countries outside the region. As a traditional space power, Japan has used the Asia Pacific Regional Space Agency Forum (APRSAF) as a space diplomacy tool and formed a regional space competitive pattern with the APSCO led by China (Suzuki 2007, 73-80). Pakistan, as a founding member of APSCO, also participated in the APRSAF through different government entities (APRSAF 2022). Pakistan and the US resumed contact in space at the beginning of this century. In 2004, NASA and the United States Agency for International Development (USAID) jointly established the transgovernmental agency SERVIR to carry out cross-border environmental management globally. NASA uses its advanced satellite technology to help countries improve decision-making for the environment and natural resource utilization. In 2010, SUPARCO represented Pakistan to join the SERVIR Hindu Kush Himalaya Regional Branch Center (SERVIR-HKH) regional hub in South Asia (SERVIR Global 2019). The above-mentioned cooperation between Pakistan and foreign countries illustrates Pakistan's space for diplomatic thought, which prioritizes immediate national interests. The negative discourses like the "China Threat Theory" and "BRI Debt Trap" that continue to spread in Western countries' interactions with Pakistan, along with frequent abnormal regime changes within Pakistan, highlight the potential risks in China-Pakistan space cooperation.

Some Western scholars have accused China of practicing "neo-colonialism" by monopolizing the space service market within the BRI and exporting soft power such as political values and ideology to the space commons (Davis 2018, 29-30). The CPEC has been strictly scrutinized, while some Western media continue to spread the idea that China is driving Pakistan into a debt trap, exacerbating Pakistan's sluggish economy and forming a vicious spiral of more reliance on Chinese capital injection (Hurley ed. 2018, 19-21). In fact, research has shown that such an accusation lacks clear evidence of China using funds to operate political and economic leverage between recipient countries (Ferchen 2018). It is an unfounded fallacy to equate the debt distress of recipient countries with China's national interests. Cai Jianhui pointed out through the analysis of the Pakistani government's long-term financial statistics that bilateral debt is not the main component of the country's foreign debt. The debt pressures of most BRI countries are fundamentally rooted in the global impact of the US Fed's cyclical interest rate hikes (Cai ed. 2019). Although there are lots of prejudices in international public opinion, it also exposes the objective fact of Pakistan's long-term economic weakness. Political corruption and internal ethnic conflicts have hindered foreign investment for decades. Many past space projects could not be realized due to funding issues. Since 2020, the macroeconomy has fallen into a severe recession affected by the pandemic, which has further intensified into a political crisis. Due to the sharp deterioration of the domestic fiscal deficit, in March 2022, Pakistani Minister of Science and Technology Fawad Chaudhry confirmed that SUPARCO had decided to postpone its original plan with China to send astronauts into space (Pons 2022).

As the all-weather strategic cooperative partner, China continues to support Pakistan in this difficult time by providing a loan of 15 billion RMB to the new Pakistani government to alleviate the economic crisis in 2022. The loan plays a supportive role in stabilizing various construction projects, including the space projects under the CPEC (Sputnik News 2022). Despite many obstacles, positive factors indicate that China-Pakistan space cooperation still has a broad prospect, given the common interests, strategic objectives, and solid friendship between the two countries.

Opportunities and prospects for China-Pakistan space cooperation

The scope of space development effects spans from the low-political field of economics and society to the high-political arena of military and diplomacy. Political friendships between state actors are crucial for space cooperation. Objective data shows the "political dividend" spilled out from the solid foundation of China and Pakistan and that China has maintained Pakistan's largest trading partner since 2015 (The Belt and Road Database 2022). China's consistent support for software and hardware has strengthened trust between the two countries. The space program is a critical component of China's overall aid to Pakistan. After the BRI and the Space Silk Road Initiative were proposed, the two countries made the statement at the establishment of an all-weather strategic cooperative partnership in 2015 to promote cooperation comprehensively in space technology applications. Pakistan is the first Asian country to carry out satellite cooperation with China under the BRI framework. Long-term political mutual trust has played an important role. For China, Pakistan provides an output path and optimizes the learning curve for its advanced space technology and manufacturing capabilities. For example, PRSS-1 and PakTES 1A satellites were launched into orbit by the Long March 2C carrier rocket, applying the world-leading "one rocket, multiple satellites" technology (Xinhuanet 2018). The diffusion of technology and the actual needs presented by the two countries in the space field are further projected into a series of satellite plans in Pakistan's Space Vision 2040, with the collaboration of medium- and long-term infrastructure constructions under the CPEC. Thus, a higher-level complementarity is fully reflected—China is Pakistan's core strategic partner to realize the future space vision, while Pakistan is China's indispensable member in the promotion of great power diplomacy.

The nature of space as a global commons makes it an extension of global governance (He and Huang 2022, 61). China's increasing influence in global governance has led to the rise of the South-South cooperation model in space. The China-Pakistan space cooperation model could serve as a reference for China in its cooperation with other Asian, African, and Latin American countries. The future

prospects of China-Pakistan space cooperation can be implemented in the following aspects: First, cooperation in the space environment's governance. The widespread use of space technology, with numerous spacecraft launched into space, results in a growing number of space debris. Due to the high-speed environment in Earth orbits, space debris affects the normal operation of space assets and poses risks and hazards to space activities. There are a total of 21,901 man-made objects in Earth's orbit, except for the 4,450 operational satellites (NASA 2019, 10). Space debris is caused by the activities of a few space powers, and the safety issues and damages are shared by all countries on Earth, creating unfair external risks for developing countries, including Pakistan. At the COPUOS committee meeting in 2022, Pakistani representatives expressed serious concerns about space debris on behalf of developing countries, emphasizing that space debris mitigation is a "common but differentiated" mission and that space superpowers should bear the main responsibility (UNOOSA 2022). With the dual identities of a space superpower and a developing country, China began its debris control plan in 2000. In 2010, the "Interim Measures for the Management of Space Debris Mitigation and Protection" were issued as the beginning of the official initiative on space debris (Mu and Fan 2015, 425-426). In 2021, the "Shijian 21" satellite was launched to verify current debris resolution (The Hindu, 2021). China and Pakistan share common interests in space and environmental governance. In the future, the two countries could promote engineering progress on debris mitigation technology and governance norms and strengthen the discourse power of the vast developing countries on the issue of a sustainable space environment.

The second is to strengthen the construction of multi-layer cooperation mechanisms from transnational, regional, to global levels. Since the 2010s, China and Pakistan have carried out a unique paradigm of integrating outer space development and surface regional cooperation, creating a foundation for China to promote space cooperation with other BRI countries and ultimately achieve the full-regional cooperation of the Space Silk Road Initiative. On the other hand, as a global intergovernmental organization, APSCO’s core momentum is the professional

working networks among various levels of member states' official space departments. Talent training has become the most important link to assist developing countries, including Pakistan, in building space capacity, as China is the only space superpower in the organization. Julie Michelle Klinger pointed out that APSCO's policy practice aligns with the implementation of the BRI and the Space Silk Road. The Space Silk Road is consistent with the strategic cooperation of APSCO member countries. The goal of building a community with common interests, responsibilities, and destiny proposed by the BRI is in line with APSCO's vision (Klinger 2018, 62-64). In the future, the prospect of an all-round space cooperative network could be seen as follows: The bilateral level of cooperation modeled on China-Pakistan space cooperation is set as the base. The small multilateral cooperation under the BRI and the Space Silk Road will be an extension. Multilateral cooperation will be generated by the expanding membership of APSCO at the international level. Therefore, tackling issues like space demilitarization, space environment governance, and fair allocation of orbital spectrum, which are concerns as the Long-Term Sustainability of Space Activities (LTSOSA) to global developing countries (Yan 2019, 51-58), will become the synergy display of China-Pakistan space cooperation as the starting point of a grand blueprint.

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