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International Cooperation Management Practice of Space Science Missions in China and Related Thinkings —Case Study on Strategic Priority Research Program on Space Science of the Chinese Academy of Sciences

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Abstract
International cooperation is an objective need for space science development, and also a necessary path for China to approach the stage center of the world space science. The scientific mission series under China’s Strategic Priority Program on Space Science (SPP) involve comprehensive, extensive, all-round, and multi-level international cooperation in the whole life cycle of mission innovation chain. International cooperation partners include ESA and major European space countries, as well as the United States, Russia, Canada, Australia, Japan, Singapore, etc. To ensure the originality and significance of the scientific objectives of the SPP missions, a swath of measures have been applied, including establishing bilateral meeting mechanism, co-establishing international research institutions, promoting international exchanges and cooperation, deepening the mission international study, and optimizing the advanced detection payloads configuration. To facilitate the output of high impact scientific achievements, the engineering management and science management of the cooperative missions are strengthened by implementing the mechanism of Co-Principal Investigators both at the mission level and the payload level. This paper reviews the international cooperation activities and management practice of the Chinese space science missions, and offers some suggestions for the future work, in a bid to provide reference for the follow-up management of international cooperation missions.

Keywords
space science; Strategic Priority Program on Space Science; space science satellite; international cooperation; principal investigator

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Abstract: International cooperation is an objective need for space science development, and also a necessary path for China to approach the stage center of the world space science. The scientific mission series under China’s Strategic Priority Program on Space Science (SPP) involve comprehensive, extensive, all-round, and multi-level international cooperation in the whole life cycle of mission innovation chain. International cooperation partners include ESA and major European space countries, as well as the US, Russia, Canada, Australia, Japan, Singapore, etc. To ensure the originality and significance of the scientific objectives of the SPP missions, a swath of measures have been applied, including establishing bilateral meeting mechanism, co-establishing international research institutions, promoting international exchanges and cooperation, deepening the international study of the mission, and optimizing the advanced payload detection configuration. To facilitate the output of high impact scientific achievements, the engineering management and science management of the cooperative missions are strengthened by implementing the mechanism of Co-Principal Investigators both at the mission level and the payload level. This paper reviews the international cooperation activities and management practice of the Chinese space science missions, and offers some suggestions for the future work, in a bid to provide references for the follow-up management of international cooperation missions. DOI: 10.16418/j.issn.1000-3045.20200412001-en

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Internationalization of scientific and technological innovation is a process in which a country or research institution actively participates in the global scientific and technological cooperation and competition to jointly cope with the international problems and challenges and utilize the global resources in the field of science and technology to improve their innovation ability [3]. It is an important driving force for industrial integration, people-to-people exchange, and win-win cooperation, and thus becomes a new great symbol of “the Belt and Road” (the Silk Road Economic Belt and the 21st Century Maritime Silk Road) in the new era [2].

It is a shared dream of all mankind to explore the universe and use the outer space peacefully. With the economic development and technological progress, the number of countries involved in the exploration of space science is increasing, and the exploration depth and breadth are expanding. We have entered a new era of all-round development and diversification, and international cooperation has become an important characteristic and trend in the exploration of space science. Cassini-Huygens mission launched in October 1997 was carried out by the National Aeronautics and Space Administration (NASA), European Space Agency (ESA), and Italian Space Agency (ASI), and more than 5 000 scientists and engineers from 27 countries participated. It is one of the most exciting international cooperation projects since the advent of the space age, and produces major results [4]. Hubble Space Telescope (HST) carried out by NASA and ESA, “Geospace Double Star Project” (hereinafter referred to as “DSP”) carried out by China National Space Administration (CNSA) and ESA, and DSP-Cluster six-point coordinated exploration [4], and other projects have made great achievements. Most problems in the research of space science are common to and concerned by mankind, and features of the discipline, scientific discovery, fund input, and scientific output demand have determined the international cooperation as an objective need for space science development [5], and a necessary path for China to approach the stage center of the world space science.

With Chinese Academy of Sciences (CAS) Strategic Priority Research Program on Space Science (hereinafter referred to as “Strategic Priority Program on Space Science”), China, for the first time, has a systematic support program in the space science mission [6], with each mission containing important international cooperation elements. The general
objective for Strategic Priority Program on Space Science is to achieve major breakthroughs in scientific innovation by implementing independent and international cooperative science satellite program in the hottest areas of science having the greatest advantages and the highest potential for major scientific discovery, so as to promote the leapfrog development of relevant high technologies and realize the important strategic role of space science in the development of China. The program aimed at two scientific frontiers (the origin and evolution of the universe and life, the relationship between solar system and human beings), and has yielded major scientific results in its Dark Matter Particle Explorer (DAMPE), SJ-10 Recoverable Scientific Experimental Satellite (SJ-10), Quantum Experiments at Space Scale (QUESS), Hard X-ray Modulation Telescope (Insight), and Microgravity Experimental Satellite (TJ-1). Missions in progress, such as Gravitational wave high-energy Electromagnetic Counterpart All-sky Monitor (GECAM), Advanced Space-based Solar Observatory (ASO-S), Einstein Probe (EP), and Solar wind Magnetosphere Ionosphere Link Explorer (SMILE)\(^\text{12}\) are progressing smoothly, and these missions contain important international cooperation elements.

As an overall supporting institution for Strategic Priority Program on Space Science and its scientific mission series (hereinafter referred to as “Overall Institution for the Program”), National Space Science Center of CAS (hereinafter referred to as “Space Center”) has gathered valuable experience in international cooperation on major missions. This paper reviews the international cooperation activities of the satellite missions of Strategic Priority Program on Space Science (hereinafter collectively referred to as “space science satellite mission”), and the management practices of international cooperation at different levels, and offers thinking on related work and suggestions for common problems, in a bid to provide references for the follow-up management of international cooperation missions.

1 Comprehensive, extensive, all-round, and multi-level international cooperation in China’s space science satellite missions

Comprehensive international cooperation of space science satellite missions is that all nine satellites contain important international cooperation elements; extensive international cooperation is that in addition to ESA as well as Italy, Germany, Britain, Austria, Switzerland, France, Spain, and other European countries, China also develops cooperation with the US, Russia, Canada, Australia, Japan, and Singapore; all-round international cooperation is that China develops cooperation with other countries in the whole life cycle of satellite missions (from strategic planning, advanced research, background model, project argumentation, and engineering development to in-orbit operation and scientific output); multi-level international cooperation is that the cooperation involves multiple levels, including payload level (development, calibration), research/experiment level, and the whole mission level (deep cooperation from mission planning, proposal, development, launching, and operation to scientific output) (Table 1).

2 International cooperation management practices of China’s space science satellite missions

To ensure the originality and significance of the scientific objectives of the missions of Strategic Priority Program on Space Science, a swath of measures have been applied, including establishing bilateral strategic meeting mechanism, co-establishing international research institutions, promoting international exchanges and substantive cooperation, and deepening the international study of the missions. For the cooperation at the payload level and the research level, engineering development is promoted by implementing the mechanism of regular coordination of payload development team, and the output of achievements is facilitated by implementing the mechanism of payload Principal Investigators; for the deep cooperation at the mission level, the engineering development is promoted by the engineering team, and the output of achievements is maximized by implementing the mechanism of Co-Principal Investigators.

2.1 Co-establish bilateral strategic meeting mechanism to promote international exchanges and substantive cooperation

(1) China establishes bilateral meeting mechanisms with major aerospace organizations and countries to promote significant cooperation. ① China establishes an annual bilateral meeting mechanism with ESA, providing a good platform for the exchanges of investigators from China and Europe in space science. This platform directly promotes the China-Europe cooperation in SMILE, a joint space science satellite mission between both parties, and other aspects. At present, both China and Europe are considering cooperation in the exploration of gravitational wave. ② China establishes a bilateral meeting mechanism with Switzerland, Italy, France, Brazil, and Portugal, to strengthen the substantive cooperation in space science and reach the preliminary cooperation intention and consciousness. ③ China establishes a bilateral meeting mechanism with Russia, planning to carry out comprehensive cooperation in the design of satellite mission, research and development of instruments, payload carrying, calibration of instruments, scientific data analysis, etc.\(^\text{21}\). ④ China holds a microgravity science symposium with Asian countries every two years, to facilitate the exchanges and cooperation between China and other countries such as Japan, South Korea, and India in the microgravity science and applied research.
Table 1  International cooperation activities of the space science satellite missions

<table>
<thead>
<tr>
<th>Science missions</th>
<th>Payload level</th>
<th>Mission level</th>
<th>Research/experiment level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAMPE</td>
<td>Develop the payload of Silicon Tungsten Tracker (STK) with Switzerland and Italy; calibrate the bismuth germanate (BGO) calorimeter with Switzerland [15]</td>
<td>/</td>
<td>Study the detection results with Switzerland, Italy, etc. [16]</td>
</tr>
<tr>
<td>SJ-10</td>
<td>Study the thermal diffusion characteristic of oil components under microgravity conditions with ESA and develop the payload for the measurement of Soret coefficient [10]</td>
<td>/</td>
<td>Measure the thermal diffusion coefficient of oil components with ESA; conduct scientific experiments on space melt materials with Japan [12]</td>
</tr>
<tr>
<td>QUESs</td>
<td>/</td>
<td>/</td>
<td>Conduct satellite-to-ground quantum key distribution and application with Austria, Italy, Spain, Russia, Germany, Canada, etc. [17]; conduct experimental tests on the theoretical model of quantum decoherence with the US, Australia, etc.; conduct quantum experiment with Britain, Switzerland, etc. [18][19]</td>
</tr>
<tr>
<td>Insight</td>
<td>Calibrate the payload of Medium Energy Telescope (ME) and Low Energy Telescope (LE) with Germany [18][19]</td>
<td>/</td>
<td>Conduct gravitational wave exploration with more than 30 countries such as the US, main space countries in Europe, Brazil, India, South Korea, Japan, and Russia [18], conduct space astronomy exploration and research with Britain, Germany, India, France, etc.</td>
</tr>
<tr>
<td>TJ-I</td>
<td>Develop the payload of Hall-effect Micro Jet (HEM-JET) with Singapore</td>
<td>/</td>
<td>Conduct data analysis and research on the payload of HEM-JET</td>
</tr>
<tr>
<td>GECAM</td>
<td>/</td>
<td>/</td>
<td>Plan to conduct observation and data analysis with the US, Europe, Japan, Australia, and other countries and regions</td>
</tr>
<tr>
<td>ASO-S</td>
<td>Calibrate the payload of Lyman-alpha Solar Telescope (LST) with Italy</td>
<td>/</td>
<td>Conduct data analysis and research on the payload of LST with Italy</td>
</tr>
<tr>
<td>EP</td>
<td>Develop the payload of Follow-up X-ray Telescope (FXT) with ESA and Germany</td>
<td>/</td>
<td>Conduct data analysis and research on the payload of FXT with ESA and Germany</td>
</tr>
<tr>
<td>SMILE</td>
<td>Develop and calibrate the payload of Soft X-ray Imager (SXI), Ultraviolet Imager (UVI), and Low-energy Ion Analyzer (LIA) with ESA</td>
<td>Plan, collect, select, and conduct program design; project development, and data analysis and utilization with ESA [10]</td>
<td>Conduct data analysis and research and result output with ESA, Britain, Canada, Netherlands, Spain, Germany, Italy, Norway, Finland, Switzerland, France, etc.; NASA and another more than ten countries participate in the data analysis and research [20]</td>
</tr>
</tbody>
</table>

(2) China maintains communication with American investigators and explores new channels of cooperation. Scientists in both countries have been maintaining communication, though the official cooperation has yet started [22]. The Forum for New Leaders in Space Science co-sponsored by CAS and National Academy of Sciences (NAS), is held once a year, and ten sessions have been held up to the end of 2019. In the forum, the frontier issues in space physics and space astronomy are discussed, which builds an exchange platform for outstanding young scientists from China and the US, and expands new channels for Sino-US cooperation in space science.

(3) China makes full use of international communication platform to show a true China. The Committee on Space Research (COSPAR) is the supreme international academic organization in the space research. Since China’s joining COSPAR in 1993, Chinese scientists have played an increasingly important role in the organization, and been actively involved in the international cooperation and coordination activities in space science and exploration. Investigator Wu Ji, Director of Strategic Priority Program on Space Science (SPP II), was the vice chairman of COSPAR (July 2010–July 2018), and Academician Wang Chi, Director of Strategic Priority Program on Space Science (SPP II), is the Member of Executive Board of COSPAR (July 2018 to the present). In addition, the Space Center is attached to the Chinese National Committee for COSPAR (CNCCOSPAR). The Overall Institution for the Program makes the most of COSPAR to promote the exchanges and cooperation between China and other scientific communities in the research of satellites and space aircrafts and advance the leapfrog development of China’s space science.

2.2 Co-establish international research institutions of space science and deepen international study to ensure the originality and significance of scientific objectives

(1) International Space Science Institute-Beijing (ISSI-BJ) is co-established, which lays a solid foundation for the strategic planning and forward-looking layout of space science. ISSI-BJ is co-established by the Space Center and ISSI which is located in Berne, Switzerland. ISSI-BJ as the only branch of ISSI shares the resources of international committee on space science and the research tools, and keeps close contact with international space science community [23]. ISSI-BJ provides a major platform for China’s international research...
in space science, thus becoming an important window for China to learn about the latest international frontier science and to be learned by the international space science community, which lays a solid foundation for the strategic planning and forward-looking layout of space science. Scientists from international space science community are widely attracted. They cooperate to study and solve new scientific problems and design the future missions by international forum, symposium, special sessions, working team, scientific team, and other activities, and thus realize the exciting ideas. Since its inception in July 2013 to the end of 2019, ISSI-BJ has organized 20 international forums, where scientists in 38 international cooperation teams from more than 50 countries collaborate on the research of space science.

(2) International study of the missions of advanced research and background models is deepened to ensure the originality and significance of scientific objectives. ISSI-BJ organizes international forums on the missions of advanced research and background models of space science, and international scientists in the forefront of scientific research are invited to discuss and study the scientific objectives, technical needs, and international cooperation prospects of the candidate projects. According to the opinions and suggestions of the international space science community, the scientific objectives are further summarized, thus improving the originality and significance of the objectives of the missions. ISSI-BJ carries out discussions on different disciplines and subjects in space science, and makes major achievements in the development planning, mission concept and key technology, selection of scientific detection instruments, scientific data and application, etc. The ongoing ASO-S, EP, and SMILE satellite missions have been studied by international consultation organized by ISSI-BJ in the background model phase.

2.3 Implement the mechanism of regular coordination of payload development team to promote engineering development and the mechanism of payload Principal Investigators to promote the output of achievements at the payload level and the research level

(1) A payload development team is co-established to promote the engineering development by implementing regular coordination mechanism. Management of the cooperative development of payload of Follow-up X-ray Telescope (FXT) for EP satellite. CAS, ESA, and Max Planck Institute for Extraterrestrial Physics (MPE) co-establish a payload development team, and promote the payload development by signing a cooperation agreement, participating in the reviews of important nodes of the payload, and holding regular working meetings. Management of the cooperative development of payload of DAMPE Silicon-Tungsten Tracker (STK). Since the cooperation began in the later phase, STK was included in the management of undersupplied projects in the prototype phase, and the participants were required to carry out the development according to the project progress. In the flight model phase, from January to March 2015, China, Switzerland, and Italy held the video conference every week to learn about the details and decided, according to the progress, to complete the environmental test of the STK models in China. They urged the population units of payload mission to strengthen the supply of human and material resources to ensure the timely return of STK and delivery of the model products. They also made plans related to the exit and entry of STK in advance.

(2) Science teams are co-established and the mechanism of payload Principal Investigators is implemented to promote the output of achievements. Cooperative countries form the science teams responsible for analysis and research of data and output of achievements in DAMPE, SJ-10, EP, ASO-S, and other satellites. Science teams organize regular meetings to discuss their research progress to promote the output of achievements. For example, the DAMPE science team formed by the investigators from China, Switzerland, and Italy are working hard to analyze the data, hoping to find the traces of dark matter soon. The mechanism of Principal Investigators is implemented for the co-developed payloads. Payload Principal Investigator (payload PI) is set up for the party with larger fund and human input, and payload Co-Principal Investigator (payload Co-PI) is set up for the other party. Payload PI, equivalent to a principal investigator assistant that links investigators and engineers and technicians, is responsible for realizing the ideas of investigators in payload design; coordinating the product development of payload development teams; carrying out the top-level design of payload system with payload development teams; deeply participating in the development, testing, and in-orbit operation of payload, so as to promote the organic integration of science and technology and the output of their achievements.

2.4 Promote engineering development by engineering team and optimize the output of achievements by implementing the mechanism of Co-Principal Investigators at the mission level

(1) A mission steering committee is co-established to guide the engineering development by the engineering teams. Cooperative countries co-establish a mission steering committee as the supreme decision-making body of the missions, which is composed of representatives from government agencies and regulatory agencies of institutes of both countries. It is responsible for coordinating and supervising major management and funds, reviewing key nodes, and guiding the missions. Moreover, both countries set up their respective engineering team and payload development team to develop and manage their respective missions according to their respective space regulations. Both countries set up their own project managers responsible for promoting engineering implementation as well as acting as the contact person at the project level. Problems unsolved by project managers can be
submitted to the joint steering committee. For example, the possible problems in the development of Sino-EU SMILE mission are effectively solved by organizing major conferences, carrying out review of milestone nodes, holding regular joint engineering meetings (twice a year), etc., and making full use of the mechanism of biweekly video meeting to ensure the smooth communication and timely coordination between China and Europe.

(2) Science working team is co-established and the mechanism of Co-Principal Investigators is implemented to maximize the output of achievements. China and Europe co-establish a science working team, and set up their respective Principal Investigators when they make roughly equal contributions (such as SMILE mission). The Principal Investigators are responsible for issues related to scientific objectives, solving scientific problems, carrying out academic exchanges, and thus maximizing the scientific performance of missions. The Principal Investigators not only propose the scientific objectives, but also practice and organize the follow-up scientific research, playing a decisive role in the scientific mission \([6]\). In the phase of project approval and demonstration, the Principal Investigators organize to set up the scientific objectives and payload configuration; in the phase of project implementation, they give suggestions on technical issues affecting scientific performance, and monitor the implementation status and readiness for instrument operation, as well as the infrastructure for data processing; in the phase of operation and application, they lead the scientific data analysis and application, coordinate science teams to play the role of groups, and ensure the output of high impact scientific achievements \([26,27]\). The science working team represents the science teams of China and Europe, and is co-chaired by the Principal Investigators, who are also responsible for coordinating the activities of the teams. The science working team includes payload PI and payload Co-PI, as well as groups such as model working group, data format working group, and payload calibration working group. The model working group is responsible for carrying out relevant model research and thus provides theoretical basis for the follow-up scientific data application; the data format working group and payload calibration working group are responsible for unifying the formats of payload data products at all levels, and focus on the laboratory calibration and in-orbit calibration of payloads, to realize the quantification of the scientific data. The science working team and its working groups organize joint conferences on a regular basis, and share their respective work progress, so as to maximize the output.

3 Thinkings and suggestions on the international cooperation of China’s space science satellite missions

The comprehensive, extensive, all-round, and multi-level substantive international cooperation for the space science satellite missions suggests that China’s strength in space science has been widely recognized by the international community, enhancing China’s international status and discourse power in the space circle. The capacity of space science exploration of China is also improved by introducing advanced scientific payloads. However, the elongation of domestic and foreign management chains and the significantly increased uncertainties in technology, quality, and progress also increase the complexity of the technology and management of the project, and bring challenges to the implementation and decision-making of the missions. To ensure the success of international cooperation projects and the output of major achievements, five suggestions are presented in view of common issues in international politics, economy, culture, and other fields.

3.1 Seize opportunities and attach importance to risks in response to the impact of international political situation

At the beginning of the 21st century, the challenges and opportunities exist alongside each other in China’s international space cooperation. As a rising space power, China is capable of and in need of international cooperation. China’s Space Activities in 2000 \([28]\) indicate that China will in the new century carry out international space cooperation on the basis of equality and mutual benefit, mutual complementarity, and common development, and peacefully develop and use space resources for the benefit of all mankind. With the success in the DSP with ESA, China has earned its place in the field of international space science, which demonstrates China’s strength and level, and strengthens the confidence and determination for Sino-EU cooperation in space. Then, China and Europe have cooperated closely for the implementation of China’s lunar exploration mission. However, ideology and international relationships are still important factors affecting the international cooperation. In 1999, the US argued in the Cox Report that China had stolen its aerospace technology \([29]\). Since then, there has been little substantive space cooperation between the two countries. Especially in recent years, basing on its hegemonism and the belief that China’s progress in space poses challenges and threats to its national security \([30]\), the US has been blocking China in the bilateral and multilateral organizations, bringing severe challenges to China’s cooperation with other western countries.

In response to the impact of international political situation, we should continue the innovative development and improve the capacity of independent innovation, and expand international exchanges and cooperation in all respects on the basis of equality and mutual benefit, peaceful use, and common development. In space science, the following aspects should be considered. ① We should strengthen exchanges and cooperation with European countries or organizations including Russia. ② For the US and its allies, we can promote the exchanges and cooperation with their scientists, research institutions or social groups by nongovernmental channels in scientific research or experiments. ③
For the existing international satellite missions, we should clarify our position of not using the components and parts listed in the International Traffic in Arms Regulations (ITAR). While promoting the international cooperation, China needs to accumulate and prepare its own core technologies in key areas to enhance the research and development capacity of relevant products. When necessary, openness and cooperation and independent research and development can be conducted simultaneously so that the progress and success of the project will not be affected. We should strengthen the exchanges and cooperation with developing countries.

3.2 Assess risks and explore feasible approaches in response to the impact of international economic situation

Influenced by the international economic situation, there is great uncertainty in the approval of international cooperative missions and their smooth implementation after approval, so we should fully assess the acceptability of risks. At present, Kuafu Mission, a major international cooperative mission of Strategic Priority Program on Space Science (SPP 1), is suspended when the funding channels and partners have still been unsettled due to the changes in the international financial situation such as fiscal austerity and financial crisis abroad \([31,32]\). In such cases, it is necessary for cooperative countries to explore feasible approaches to persisting in the missions without changing the original scientific objectives.

3.3 Enhance mutual understanding and trust in response to the differences in system, mechanism, culture, language, etc.

Each country has its own unique ideology, so there are huge differences in the concept of space engineering development and the attitude towards work and life. Some of China’s traditional space practices (such as establishing a return channel of satellites in the rocket launch segment) are considered unnecessary by European countries; European countries have strictly demonstrated and provided specific requirements for technical indicators from scientific objectives to mission needs, which need to be strengthened in China; it is common for Chinese researchers to work overtime to speed up the process, while those in Europe focus more on their family and life, and thus seldom overwork; engineering allowance also varies. The more differences there are, the more open, transparent, and empathetic we should be. We should also improve our oral English competence to accurately express ourselves, thus reducing concerns and barriers and enhancing mutual understanding and trust. This is the foundation of successful international cooperation.

3.4 Strengthen progress risk control in response to the inconsistent development processes

For example, in the SMILE mission, Europe adopted its own standards in the development process, which was quite different from the conventional practice of China. Inconsistencies in the planning process of trial and test and the time to determine technical status also brought risks to the overall development process. Therefore, the following three suggestions are given. ① The technical process and planning process of the whole satellite are designed based on the difference in the development processes of China and Europe, and the key nodes are selected and confirmed by China and Europe. During the development process, both parties control their own progress according to the key nodes. ② A systematic planning process is formed, a team is established to manage the risks affecting the progress, and a thematic plan is developed, and controlled and managed as a key undersupplied project. ③ A system of regular scheduling meeting is established and strictly implemented to understand and coordinate the problems in the development process at any time. Any significant impact on the implementation plan must be reported to the other part and solved in a timely manner to ensure the development process.

3.5 Communicate and coordinate timely and perform document control in response to interface mismatch

International cooperative missions involve communication and coordination between countries, and document translations and language barriers may lead to various problems. For example, the Spektr-RG satellite developed by Russia and Germany was successfully launched on July 13, 2019. But before that, poor communication and coordination in the development process resulted in the mismatch between the control software and wireless system and the instrument and thus the stoppage of the test, which affected the development cycle and cost \([33]\). China’s space science satellite missions also involve cooperation with various countries and organizations, with complex interface management. Especially in the SMILE mission, various interfaces are involved, including those between satellites and carrying, satellites and earth segment (launching site system, ground supporting system, measuring and controlling system, scientific application system), systems in the earth segment, satellite platform and payload cabin, and payload cabin and payload. To ensure the matching of interfaces, three aspects need to be focused on. ① Cooperative countries should formulate, detail, sign, and implement interface documents, specify the mission baselines and interfaces, solidify technical conditions, test process, etc., so as to ensure the integrity and clarity of interfaces. ② Cooperative countries should ensure the timely and accurate translation of documents regarding interface control, installation integration test, and flight test. Especially when the documents change, both countries must update the documents simultaneously and control the version. ③ Both countries should maintain close and smooth communication and keep track of each other’s development progress and interface changes in real time.
4 Conclusion

It is a shared dream of all mankind to explore the universe, while space science, an organic combination of independent development and openness and cooperation, is an important field for international cooperation. Roger M. Bonnet, winner of the Friendship Awards of China, has pointed out that “the role of international cooperation in space science cannot be overemphasized, and is imperative for space science.” Through international cooperation, we can absorb international forces, expand research fields, enrich research content, improve independent research and development capacity, enhance our international status and discourse content, improve independent research and development of space science. With such considerable progress in the space science and technology, China still lags far behind the major space powers. China needs to strengthen the international cooperation on the basis of mutual complementarity, mutual benefit and win-win result to promote the long-term sustainable development of China’s space science and better exploration and use of space by mankind.

References


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