The Chinese Academy of Sciences' Contributions to Global Open Access

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Abstract

The open access movement has undergone approximately two decades of development, achieving notable progress including the promotion of open access to scientific papers and open sharing of scientific data to a considerable extent. As a globally influential major power in science and technology, China's engagement in and promotion of open access and open science not only advances its own scientific and technological development but also constitutes a crucial manifestation of sci-tech self-reliance and strength. This article retrospectively examines and systematically surveys the principal measures and experiences of China, particularly the Chinese Academy of Sciences, in promoting global open access, identifying and discovering important information and key events. Based on a review of China's open science development experience, it summarizes existing problems in the current development of open science in China and proposes recommendations for future development.

Full Text

Preamble

Contribution of the Chinese Academy of Sciences in the Promotion of Open Access to the World

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Abstract

The open access movement has spanned approximately two decades and achieved notable progress, including advancing open access to scientific papers and promoting open sharing of scientific data to a certain extent. As a major global power in science and technology, China's participation in and promotion of open access and open science not only fosters the development of its own scientific and technological capabilities but also demonstrates its commitment to self-reliance and self-improvement in science and technology. This paper reviews and examines the principal measures and experiences of China, particularly the Chinese Academy of Sciences, in promoting global open access, identifying key information and pivotal events. Based on this review of China's open science development experience, the paper summarizes current challenges and proposes recommendations for future development.

Keywords: Open Science; Open Access; Hindsight; Recommendations
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1. Introduction: Learning from the Past, Staying True to Our Original Aspiration

Open science is continuously evolving, encompassing at minimum open access to scientific papers and open sharing of scientific data, among other aspects such as citizen science, crowdsourcing, and open-source software code. In other words, open science cannot be defined merely by open access journals or open research data alone; it requires the advocacy of numerous international academic organizations and the participation of multiple stakeholders to achieve. Recent significant events include: (1) On November 24, 2021 (Paris time), UNESCO released the Recommendation on Open Science [1]; (2) On December 24, 2021, China promulgated Article 95 of the Law on the Progress of Science and Technology, which explicitly addresses open science [2]; and (3) On March 17, 2022, the China Association for Science and Technology established the Special Committee for Consultation with the United Nations on Open Science and Global Partnerships [3].

Why is open science so important? Because it aims to promote scientific development, break down knowledge barriers, dismantle paywalls, oppose technological blockades, and maintain normal academic exchange—ideals that align with the spirit of the earlier global open access movement. China has witnessed generations of strategic scientists, researchers, and frontline service personnel working silently to build and resist anti-open blockade mechanisms. Many practitioners have fallen, been marginalized, or taken wrong paths before finding their way back. These histories and experiences warrant examination—not for the sake of any individual or institution, but for the advancement of China's scientific and technological endeavors.

Reviewing China's open science development experience helps us derive imple-

mentation pathways adapted to China's socio-economic development from successful cases, enabling us to continue moving forward. It also allows us to learn from failures to avoid repeating mistakes. Moreover, fully respecting previous research and acknowledging the contributions of scientists, researchers, and frontline service personnel across various stages represents both a spiritual and practical commitment to staying true to our original aspiration. Key achievements by the Chinese Academy of Sciences include: (1) The establishment of institutional repositories and preprint platforms capable of interoperability, with ongoing expansion [4,5,6,7,8]; (2) Remarkable success in gold open access pilots, with comprehensive systems for policy guidelines, payment accounting, and monitoring evaluation [9,10,11,12,13,14,15]; (3) Completion of policy research on open research data [16,17,18,19,20,21,22,23,24,25], journal pilots [26,27,28], and metadata resource construction [29,30,31,32]; and (4) Sufficient social forces for software and hardware, with exploratory research on rights related to storage, replication, and use [33,34,35,36].

This study employs the "hindsight" method of forward-looking policy research, which involves organizing and supplementing historical materials, tracing the timelines of multiple events and their interrelationships, and simulating potential outcomes of various possible scenarios at the time. We aim to identify two types of lessons: how to replicate successful models in the future and how to avoid failure scenarios. Redefining everything without historical research would be time-consuming and might fail to fully recognize underlying patterns and contradictions. At this juncture, we offer this work to spark further discussion.

2. Originating from Global Scientists' Joint Initiatives

The concept of open access to scientific information promotes scientific development, breaks down knowledge barriers, dismantles paywalls, opposes technological blockades, and maintains normal academic exchange. China's open access movement can be traced back to the early 21st century. In 2003, Academician Lu Yongxiang signed the Berlin Declaration on Open Access on behalf of Chinese scientists [37], and in 2004, Chen Yiyu, Director of the National Natural Science Foundation of China (NSFC), and Lu Yongxiang, President of the Chinese Academy of Sciences, signed the Berlin Declaration on Open Access on behalf of their respective institutions [38]. Since then, China has steadily and systematically developed open access policies, repositories, and journals [39,40].

In 2005, the Chinese Academy of Sciences and the InterAcademy Partnership (IAP) co-hosted the International Conference on Strategies and Policies for Open Access to Scientific Information, organized by the National Science Library of the Chinese Academy of Sciences. The conference attracted representatives from over 60 countries, with attendees including Hu Qiheng, Vice Chair of the China Association for Science and Technology; Guo Huadong, Assistant Director-General of the Chinese Academy of Sciences and Director-General of the Bureau of International Cooperation; Yuan Haibo, Director of the National Science and Technology Library; and Liu Xiaoqin, Deputy Director-General of

the Department of Social Culture and Library Affairs of the Ministry of Culture [41]. In 2006, the National Science Library undertook a research project for the NSFC on strategies and policies for open access to scientific information, analyzing international trends, strategies, policies, and related legal and management mechanisms, and launched China's first open access advocacy website [42]. Beginning in 2007, the National Science Library participated in a China-Germany cooperation project funded by the NSFC's China-Germany Center and the German Research Foundation, including collaboration with the University of Göttingen on open access [43]. From 2008 to 2009, the Chinese Academy of Sciences launched its institutional repository grid construction project, initiating large-scale development of institute-level repositories [44,45]. In 2009, the Chinese Academy of Sciences became the first institution in China to fund authors publishing in the open access journal group BioMed Central (BMC) [46]. In October 2010, the Chinese Academy of Sciences and the Max Planck Society co-hosted the 8th Berlin Conference on Open Access, where they presented strategies for open access to scientific information [47]. In 2011, the Bureau of Planning and Finance of the Chinese Academy of Sciences issued the "Interim Measures for the Management of Intellectual Property Rights in Research Institutes of the Chinese Academy of Sciences" [48]. In 2012, the Chinese Academy of Sciences signed the institutional letter of intent for the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP3) [49]; in the same year, the National Science Library organized 23 research institute and university libraries to establish the China Institutional Repository Promotion Working Group and the China arXiv Service Working Group, and launched the annual China Open Access Week in October [50]. During 2013-2014, the Chinese Academy of Sciences organized an academic consultation report on international open access strategies and practices, providing policy recommendations to higher authorities [51]; in 2014, the Chinese Academy of Sciences also negotiated important issues for the Global Research Council [52].

4. Actively Embracing "China Open" Through Grassroots Practice

At the press briefing for the Global Research Council 2014 Beijing Meeting on May 15, 2014, the Chinese Academy of Sciences and the National Natural Science Foundation of China respectively released policy statements requiring open access for papers from publicly funded research projects. These statements mandated that final accepted manuscripts be deposited in appropriate repositories and made openly accessible within 12 months of publication [53]. At the third Global Research Council Beijing Conference, Premier Li Keqiang addressed representatives from over 120 countries' funding agencies and research institutions, expressing China's continued support for the open sharing of scientific information and intellectual property protection, while also emphasizing attention to young scientists' development [54]. In the same year, the Chinese Academy of Sciences, together with the German Research Foundation and the Natural Sciences and Engineering Research Council of Canada, completed the "Global

Research Council Open Access Action Plan Implementation Survey Report" [55].

In March 2015, the National Science Library reached an automatic paper deposit agreement with the Institute of Physics Publishing (IOPP) and other institutions [56]; it also collaborated with Thomson Reuters (now Clarivate Analytics) to establish links between the Chinese Academy of Sciences Institutional Repository Network and Web of Science [57]. In May 2015, the NSFC released the "Implementation Rules for the Open Access Policy of the NSFC Basic Research Repository" [58] to collect full-text research papers from NSFC-funded projects and provide open access to the public, disseminating cutting-edge scientific and technological achievements in basic research to promote scientific progress. In 2016, the National Science Library launched its "preprint system" service [59]; in the same year, the Ministry of Education issued the "Action Plan for Promoting the Transfer and Transformation of Scientific and Technological Achievements in Higher Education Institutions," which required opening scientific data, papers, research facilities, and equipment to innovation and entrepreneurship groups, and providing relevant information on scientific and technological achievements to strengthen the open sharing of university innovation resources [60]. In July 2017, the National Science Library, representing the China Institutional Repository Promotion Working Group, signed the "International Accord for the Alignment of Repository Networks" [61]. In 2017, the NSFC held a thematic symposium on "Open Science Promoting Scientific Innovation" [62]; in 2018, the National Science and Technology Library held an expert discussion meeting on open access policy recommendations [63]; and in November 2018, the NSFC held the Shuangqing Forum on "Open Science Policy and Practice" [64].

In 2017, the National Science and Technology Library signed the OA2020 Initiative [65]. In 2019, the China Association for Science and Technology, the Publicity Department of the CPC Central Committee, the Ministry of Education, and the Ministry of Science and Technology jointly issued the "Opinions on Deepening Reform to Cultivate World-Class Scientific and Technological Journals," which clarified China's development goals for scientific journals and proposed measures and approaches to achieve them [66]. In March 2021, the Ministry of Education issued the "Specifications for Digital Campus Construction in Higher Education Institutions (Trial)," which included six standards for institutional repositories (optional) in section 6.5.5 [67]. On November 24, 2021 (Paris time), UNESCO released its Recommendation on Open Science [68], and on November 25, 2021 (Beijing time), the China Association for Science and Technology released the "China Scientific Journals Blue Book 2021: Academic Publishing in an Open Science Environment" [69]. On December 24, 2021, China's Law on the Progress of Science and Technology, Article 95, stipulated: "The state shall strengthen the construction of academic journals, improve the exchange mechanism for research papers and scientific and technological information, promote the development of open science, and facilitate the exchange and dissemination of science and technology" [70]. In April 2022, the Chinese Academy of Sciences

launched the key academic consultation project "Trends and Impacts of Open Science" [71]. Thus, building on 18 years of open access development, China has formally established open science, including open access, as one of its national science and technology development directions.

6. Current Problems and Future Development Recommendations

Strategic scientists, researchers, research informatization workers, and numerous social organizations have made concerted efforts under national strategy guidance. As grassroots librarians who have participated in open access initiatives, we bear responsibility for identifying potential problems and offering recommendations based on past experience.

First, institutional repositories lack long-term investment and operation, have not formed a nationally interconnected network, and have not achieved interoperability with major global institutional repository clusters. Open science cannot function without open access to scientific information and open sharing of research data. The former operates through a dual-track system, and institutional repository construction extends beyond unit-level intellectual property management or the significance of informatization projects. It represents a broader scientific exchange network that includes not only contributions to digital content interoperability but also a cooperative network of librarians—expanding from early interlibrary loan to a grand union movement of librarians centered on global institutional repository networks.

Second, the per-article funding for open access papers and journals continues to rise without any downward trend or effective measures to curb it. This is a means, not an end. Currently, most Chinese research institutions still face the "double payment" dilemma of open publishing fees and library subscription fees, and open publishing has not changed the status quo or trend of soaring subscription costs for scientific literature. For China, if global authors adopted the same APC standards, the total APC fees paid by Chinese authors would far exceed (nearly double) current subscription payments [72]. Although international initiatives like OA2020 and Plan S have pressured major publishers and journals, these publishers have always found ways to respond, such as adding open publishing options or launching new open access journals. Achieving comprehensive open publishing for most scientific journals with reasonable funding remains a long and arduous road requiring sustained multi-party efforts.

Third, data sharing has formed systems within disciplines but cannot extend to open data, indicating that open data systems lack the capacity and services to provide complete data chains. When discussing open data and data repositories, they appear as two separate "products," but in reality, open data (primarily open government data) and data repositories should be conceptual implementations in two different domains. Therefore, data repositories—or open sharing of research data—should actively strengthen integration with open data (open

government data), public data, and corporate open data. By leveraging existing technologies, experiences, and knowledge from rapidly advancing big data and public data practices, we can drive efficient and high-value applications of research data and open data, creating and enhancing data service capabilities.

Fourth, there is a lack of long-term preservation at the national strategic level for software code and hardware core operating system source code. Against the backdrop of China-US trade friction, software and hardware have become "weapons" in this conflict. Open-source software and open source code, as pillars of open science, could also face "blockades" imposed on China. As important digital and research resources, software and source code have not received sufficient attention relative to their importance. While open science aims to make science and scientific knowledge borderless, in the real world, various stakeholders (researchers, research institutions, publishers, integrators, software developers, hardware manufacturers, distributors, etc.) belong to specific nations.

Open access development requires long-term investment to earn respect and trust from the global scientific community. Short-term informatization funding yields few "concrete" results. However, adhering to the principle of "minimizing costs and making good use of expenditures," it is particularly important to develop plans and implementations that are both quantitatively measurable and substantially perceptible. To stimulate discussion, we offer the following recommendations:

(1) Establish interoperability among institutional repositories, preprint platforms, discovery systems, publishing platforms, and data repositories; pay membership fees to international organizations and increase membership numbers to achieve interoperability with foreign platforms and break technological blockades. Simultaneously, institutional repositories, preprint platforms, integrated literature databases, and data repositories across China must achieve interoperability and open sharing. Relevant departments and institutions can collaborate to develop more efficient "one-stop" open science knowledge discovery systems or improve compatibility and visibility based on existing discovery systems.

(2) Conduct price traceability studies anchored to core journals, establish calculation formulas, and implement unified strategic and administrative practices. Since authors pay open publishing fees and, driven by the urgent need to secure "first publication rights" and meet evaluation requirements, generally lack the capacity or willingness to negotiate reasonable prices with publishers, we recommend that national, institutional, and disciplinary levels organize relevant bodies to investigate and calculate open publishing costs, actively negotiate with publishers for reasonable pricing, and have relevant departments coordinate and manage open publishing fee payments.

(3) Achieve comprehensive upgrading of knowledge, technology, and capabilities for a new generation of data librarians. In today's data-driven scien-

tific era, librarians should actively develop themselves into qualified data librarians, possessing not only subject domain knowledge but also mastering relevant technologies and capabilities for data management and governance, while understanding relevant laws, regulations, and management methods concerning data security, data management, data rights, and related operational requirements.

(4) Implement long-term preservation plans for software core code and hardware operating system source code. Scientific self-reliance and strength are both imperative and inevitable trends. Establishing proprietary intellectual property rights for chips, hardware, and software represents the future development path. However, the immediate priority is to effectively implement long-term preservation of software core code and hardware operating system source code to ensure normal research, production, and daily life while seeking development opportunities to break various "technological blockades." We recommend that relevant departments, institutions, and organizations jointly formulate long-term preservation plans, collaborate on preserving various software and source code, and conduct research on related laws, regulations, and provisions.

7. Conclusion: Staying True to Our Mission and Forging Ahead

Reviewing China's open access development represents a step toward global open science. As previously discussed, the significance of open science for China's research enterprise lies in its opposition to blockades. However, under the banner of "normal academic exchange," the rhetorical emphasis of political leaders and funding and research institutions varies across nations.

Western powers have never ceased their technological blockade against China, continuously prohibiting the exchange and trade of key technologies and materials. In recent years, a few American politicians have led G7 nations in forming strategies and measures to contain China's development. Amid comprehensive, multi-dimensional campaigns, potential threats to scientific exchange have gradually emerged into public discourse.

In scientific diplomacy rhetoric, voices have alternately claimed that China does not practice open access, that China free-rides on global open access, or that without open access and open data, China has no open science.

In reality, from Chinese scientists signing the Berlin Declaration on Open Access in 2003, to participating in the Global Open Access Action Monitoring Plan in 2013, to UNESCO's Recommendation on Open Science on November 24, 2021, China's scientific community has never been absent, never broken its commitments, and never ceased efforts in open access to scientific papers and open sharing of scientific data. On December 24, 2021, China's Law on the Progress of Science and Technology, Article 95, stipulated: "The state shall

strengthen the construction of academic journals, improve the exchange mechanism for research papers and scientific and technological information, promote the development of open science, and facilitate the exchange and dissemination of science and technology." This formally established open science as one of China's national science and technology development directions.

China has its own path for open science and open access. Compared with the United States—where open access and open science advancement results from intense gaming, mutual cooperation, and compromise among multiple interest groups (publishers, researchers, funding agencies, librarians, etc.), with the most intense conflicts occurring between open access advocates and for-profit publishers before the 2013 White House Office of Science and Technology Policy (OSTP) memorandum "Increasing Access to the Results of Federally Funded Scientific Research" [73]—China follows a mass line approach. Through training, promotion, services, summarizing successful experiences, and learning from failed initiatives (including China Open Access Week, institutional repository workshops, China Fair Use Week, and the recent "Data Librarians Supporting Scientific Research" training course series), China has progressed step by step. Though slow and fraught with setbacks, with many pioneers and practitioners failing along the way, China has remained true to its original aspiration. Once established, its achievements will have tremendous global influence and demonstration effects.

Therefore, by reviewing the historical development of China's open access movement, we pay tribute to the intellectual and practical contributions of scholars and workers from all sectors involved in this process. Through hindsight analysis of history and participatory experience, we identify important information and key events to understand the critical elements in moving from theory to practice and from work to experience summarization. This paper does not include contributions from data sharing and open research data, nor various policy studies and informatization projects. Nevertheless, this does not prevent us from staying true to our original aspiration: engaging in open access and open science not for informatization project applications and funding (though infrastructure is necessary for content accumulation and open sharing), but to fulfill our mission of contributing, however modestly, to national scientific and technological development. As librarians, being a sturdy and durable screw in the machinery of China's scientific enterprise is a source of pride and confidence. This represents an attempt to answer, from the most grassroots and direct perspective, the macro-level question of why librarians engage in open access.

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Note: Figure translations are in progress. See original paper for figures.