

ORIGINAL ARTICLE

Progress and practice in physics journal publishing: Trends toward open access, interdisciplinarity, and cluster development

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ABSTRACT

Background: The international publishing landscape of physics journals is undergoing a significant transformation that is driven by the rapid growth of open access (OA) models, increasing interdisciplinary integration, and the trend toward cluster-based development. This shift reflects evolving modes of scholarly communication and responses to the growing need for multidisciplinary collaboration in addressing frontier scientific challenges. **Methods:** This study utilized bibliometric data from Clarivate's Journal Citation Reports (JCR) between 2022 and 2024, complemented by case analyses of major international publishers and initiatives such as the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP³). Comparative and trend analyses were used to examine the development of OA journals, interdisciplinary integration, and publisher clustering in physics. **Results:** The number of gold OA physics journals indexed in the Directory of Open Access Journals (DOAJ) increased by 23% from 2022 to 2024, significantly surpassing the overall growth rate of physics journals. Interdisciplinary journals constitute 94.6% of the physics group and generally exhibit higher impact factors than traditional single-discipline journals. Publisher clustering is prominent, with the top five publishing groups accounting for nearly 46% of physics journals by 2024. Initiatives like SCOAP³ have further advanced global OA cooperation. **Conclusion:** The physics journal publishing ecosystem is evolving toward enhanced openness, interdisciplinarity, and concentration. Although these trends enhance the efficiency and reach of scientific communication, they pose challenges related to financial sustainability, editorial fairness, and market diversity. Strategic efforts in OA adoption, interdisciplinary capacity building, and cluster development are essential for advancing physics publishing, particularly in the context of developing world-class journals with Chinese characteristics.

Key words: open access, interdisciplinary journals, cluster publishing, physics journals, scholarly communication

INTRODUCTION

Recently, the international publishing landscape of physics journals has undergone a structural transformation that is driven by three major trends: The expansion of open access (OA) models, the rise of interdisciplinary integration, and the trend toward cluster-based development. Data indicate that the number of gold OA physics journals increased by 23% between 2022 and

2024, significantly surpassing the discipline's annual article growth rate, as shown in Table 1. This growth continues to accelerate. Interdisciplinary journals constitute up to 94.6% of the physics group and generally exhibit a higher influence (*e.g.*, median impact factor) than traditional journals, underscoring the deepening integration of disciplinary boundaries. These developments signal a shift toward more open and collaborative modes of scholarly communication and

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Table 1: Annual growth in the number of DOAJ gold OA journals in the physics category from 2022 to 2024

Year	DOAJ gold OA	Annual growth rate (%)	Total physics journals	Journal growth rate (%)
2022	521	10.9	2341	0.6
2023	576	10.6	2388	2.0
2024	641	11.3	2441	2.2

DOAJ, Directory of Open Access Journal; OA, open access.

publishers' proactive adaptation to the growing demand for multidisciplinary cooperation in addressing frontier scientific challenges.

Previous studies have independently documented the rise of OA,^[1] highlighted the increasing importance of interdisciplinarity in science,^[2] and analyzed the market concentration among major publishers.^[3] Although informative, few studies have simultaneously examined the interplay of these three trends in physics. Moreover, the strategic implications for national scientific publishing systems like those of China, which are actively seeking to enhance their international influence, remain less explored.

This study seeks to contribute to research in the field of physics journal publishing by conducting an integrated analysis of OA, interdisciplinary integration, and cluster development. This analysis is evidenced by Clarivate's Journal Citation Reports (JCR) data, which record 2441 international physics journals, 627 Directory of Open Access Journals (DOAJ)-certified gold OA titles, and 8825 involved publishers as of 2024. By combining bibliometric data with case studies of international initiatives and publishers, we aim to explore the connections between these trends. We also attempt to draw preliminary insights from global observations that may inform the cultivation of scientific journals with Chinese characteristics.

METHODS

This study utilized bibliometric data from Clarivate's JCR based on the Web of Science Core Collection from 2022 to 2024, along with case analyses of major international publishers and initiatives such as the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP³). Comparative and trend analyses were used to examine the development of OA journals, interdisciplinary integration, and publisher clustering in physics.

RESULTS AND DISCUSSION

Trends in OA for international physics journals

OA physics journals have demonstrated notable growth in recent years. According to bibliometric data based on Clarivate's JCR, the number of physics journals

identified as DOAJ-certified gold OA journals in physics increased steadily from 2022 to 2024 (as shown in Table 1), with a net increase of 120 journals over three years, representing a 23.0% total increase, far exceeding the overall annual growth rate of 2.2% for physics journals. Notably, the growth rate accelerated from 10.6% in 2023 to 11.3% in 2024, indicating that physics journals are increasingly transitioning toward OA models.

This upward trend confirms that immediate, open dissemination has become a key direction in physics publishing. Since the launch of Plan S by the international funders' cOAlition S in 2018, OA transition has accelerated significantly. Plan S requires that, beginning in 2021, research outputs funded by its signatories should be published in OA journals or platforms, further promoting OA transformation in physics journals.^[4] For instance, the American Physical Society (APS) and the Institute of Physics (IOP) in the UK have been actively promoting OA transitions for their journals using transformative agreements to balance revenues and costs. APS launched its first fully OA journal in 1998 and expanded OA offerings thereafter. In 2011, it converted several high-impact journals to hybrid models to support article-level OA. Subsequently, APS introduced multiple hybrid and gold OA journals, including high-impact physics journals such as *Physical Review X*, and OA topical journals, such as *PRX Energy*, *PRX Life*, and *PRX Quantum*.^[5–9]

Complementing these policy drivers, a growing recognition of the intrinsic OA advantage provides a powerful incentive. Multiple studies have demonstrated that OA articles tend to receive more downloads and citations than subscription-based articles, enhancing research visibility and impact. For instance, a large-scale study reported that OA articles received a median of 18% more citations than non-OA articles across various disciplines.^[1] A study of hybrid journals demonstrated a significant OA advantage: OA articles attained 1.52 times more citations, 4.40 times more article views, and 1.22 times more social media attention than non-OA articles.^[10] This measurable benefit, coupled with mandates from funders (such as cOAlition S) and institutions, provides a compelling incentive for authors, publishers, and funders to support the transition to OA models, thereby fueling the growth in the number of gold OA journals.

In high-energy physics, SCOAP³, led by the European Organization for Nuclear Research (CERN), has emerged as an important model of global cooperation for open publishing. Launched in 2014, SCOAP³ has attracted participation from over 3000 libraries, research institutions, and funders across 44 countries/regions. The initiative converts institutional subscription expenditures into open publishing funds, allowing authors to publish without article processing charges (APCs) while ensuring open dissemination. China joined SCOAP³ in 2014 through the National Science and Technology Library (NSTL), which fully subsidizes publication costs for Chinese authors and demonstrates active contribution to global open science.^[11] As of September 2025, SCOAP³ has made over 77,000 articles openly accessible, more than 16,000 of which were authored by Chinese researchers.^[12] SCOAP³-funded papers now account for over 90% of the annual global output in high-energy physics, substantially facilitating the sharing of research outcomes worldwide.

In contrast to the proactive transformations of established Western publishers, Chinese scientific, technical and medical (STM) journals face distinct challenges in their OA transition. First, a significant financial sustainability hurdle exists. Many Chinese journals lack a robust funding model to cover APCs, which can be prohibitive without stable institutional or national subsidies, making them less attractive to international authors who have options to publish in well-funded OA journals elsewhere. Second, the challenge of achieving international recognition and impact exists. Building a high-impact OA journal requires attracting a global stream of high-quality submissions, which is difficult when competing with the long-established reputations and extensive international networks of publishers such as APS and IOP. This creates a cycle where lower visibility impedes the ability to attract top-tier research. Finally, policies and evaluation systems are complex. The domestic academic evaluation system in China has historically prioritized publication in high-impact-factor international journals, which can divert the best Chinese research away from domestic OA journals. Addressing these challenges requires a coordinated national strategy involving stable funding mechanisms, strategic international partnerships to boost visibility, and reforms in research assessment that value contributions to domestic journals.

The OA transition in physics journals is reflected not only in the rising number of journals but also in evolving publishing paradigms, collaborative mechanisms, and policy frameworks. From mandatory OA policies to society-led explorations and the global alliances model embodied by SCOAP³, multiple stakeholders are collectively steering the physics knowledge dissemination system toward enhanced openness and efficiency.

China's active involvement in international initiatives illustrates its commitment to integrate into and contribute to the global open science ecosystem. This transformation not only affects research dissemination but also presents new opportunities and challenges for funding, evaluation, and international collaboration.^[13–18]

Interdisciplinary development in international physics journals

Another notable development in international physics publishing is the growing emphasis on publishing interdisciplinary research. JCR data show that 28 of the 34 subject categories in the physics group are jointly classified under physics and other major disciplines, representing 94.6% of the total. Meanwhile, the number of interdisciplinary journals involving physics has steadily increased. As shown in Figure 1, the count increased from 2210 in 2022 to 2309 in 2024, and the corresponding data are shown in Table 2. The growth in the number of interdisciplinary journals closely mirrors the overall expansion of physics journals, with most newly launched journals in recent years being interdisciplinary. The substantial base and steady growth of such journals clearly indicate that accommodating and integrating cross-disciplinary research have become a key direction in physics journal development. This trend reflects the blurring boundaries between physics and fields such as materials science, chemistry, engineering, and data science. Publishers are adapting to and promoting this integration to meet the urgent need for multidisciplinary collaboration in addressing complex frontier scientific challenges.

Notably, interdisciplinary journals generally achieve higher impact factors than traditional physics journals. According to the 2024 JCR, among the journals with median impact factors across the 34 physics categories, 9 of the top 10 are interdisciplinary journals; only one is a conventional physics journal. The top three categories are Energy & Fuels, Nanoscience & Nanotechnology, and Quantum Science & Technology, spanning physics, chemistry, materials science, multidisciplinary, and engineering (Table 3).

Interdisciplinary development in physics publishing is advancing in multiple dimensions. This integration is evident not only in the growing number of journals but also in qualitative shifts in intellectual content. Cross-disciplinary collaboration is increasingly driving major scientific breakthroughs, with many innovations arising at the intersections of traditional fields. In response to this evolving research landscape, APS launched Physical Review Research in 2019 to publish work spanning physics and its intersections with chemistry, biology, computer science, and engineering.^[19] In 2025, Physical Review Applied and Physical Review Materials jointly

Table 2: Annual growth in the number of interdisciplinary journals from 2022 to 2024

Year	Interdisciplinary journals	Total physics journals	Interdisciplinary share (%)	Interdisciplinary growth	Total physics journal growth
2022	2210	2341	94.4	13	14
2023	2257	2388	94.5	47	47
2024	2309	2441	94.6	52	53

Table 3: Categories with the top 10 median impact factors in 2024

Category	Belonging group	Interdisciplinary category	Median impact factor
Energy & fuels	Chemistry, physics	√	4.4
Nanoscience & nanotechnology	Chemistry, materials science, multidisciplinary, physics	√	4.1
Quantum science & technology	Engineering, physics	√	3.7
Chemistry, physical	Chemistry, physics	√	3.3
Electrochemistry	Chemistry, physics	√	3.2
Meteorology & atmospheric sciences	Geosciences, physics	√	2.9
Physics, condensed matter	Materials science, physics	√	2.8
Physics, particles & fields	Physics	×	2.8
Biophysics	Biology & biochemistry, physics	√	2.7
Physics, applied	Multidisciplinary, physics	√	2.7

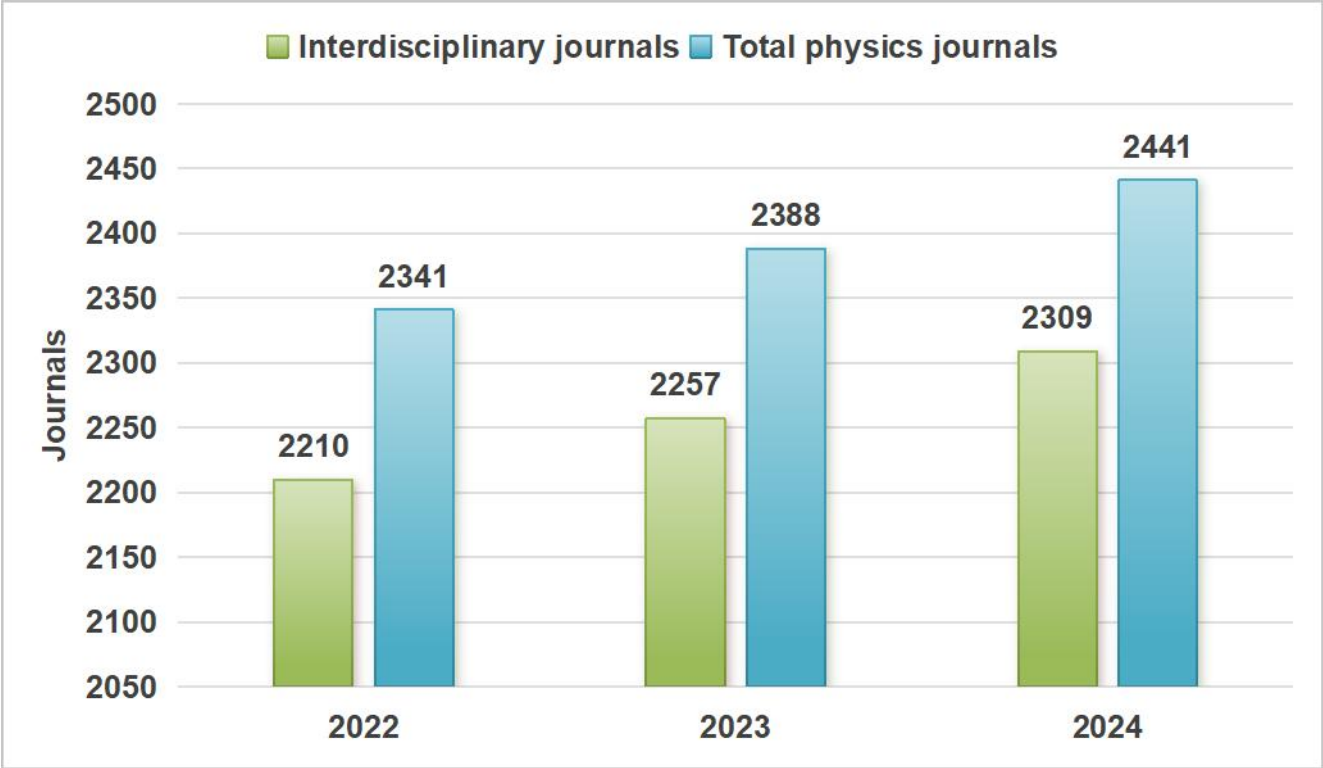


Figure 1. Annual interdisciplinary journals and total physics journals from 2022 to 2024.

launched a special collection on two-dimensional materials and devices, highlighting advances at the intersection of applied physics and materials science.^[20] As disciplinary boundaries continue to soften, problem-oriented research paradigms are becoming mainstream.

The growth in the number of interdisciplinary journals and the OA movement reinforce each other, driving structural changes in scholarly publishing. This mutual reinforcement operates through several channels: interdisciplinary research often involves diverse and interna-

tional teams, which benefits from the broader visibility and accessibility offered by OA. Meanwhile, OA platforms lower barriers to cross-disciplinary knowledge exchange, facilitating the integration of insights from multiple fields. Additionally, funding agencies and institutions that support OA often prioritize high-impact, interdisciplinary science, further incentivizing publishers to launch or convert journals that serve these converging trends. With emerging fields such as quantum technologies and artificial intelligence, interdisciplinary publishing in physics is expected to deepen. These trends necessitate innovation in editorial strategies and peer-review mechanisms, as well as coordinated efforts across governments, industries, academia, and research sectors to support interdisciplinary development. Ultimately, this will advance humanity's ever-deepening understanding of the complex material world.

Cluster development and trends in international physics journals

International physics journal publishing is characterized by significant clustering and consolidation, with a few large publishing groups dominating the knowledge dissemination ecosystem. Elsevier and Springer Nature, established over more than a century, have built "per clusters" encompassing thousands of journals. JCR statistics indicate that Elsevier and Springer Nature publish over 2300 and 2248 titles, respectively. Table 4 shows the number and share of physics journals held by the five major publishing groups (Elsevier, Springer Nature, Wiley, Taylor & Francis, and IOP Publishing Ltd.) from 2022 to 2024. Figure 2 displays the market share distribution among these publishers in 2024. Together, these publishers hold a dominant share of the field. Although the total number of journals has grown annually, the combined market share of these five groups has remained high, increasing slightly from approximately 44.5% in 2022 to 46.0% in 2024. Elsevier and Springer Nature maintain particularly stable and prominent market shares of approximately 17.0% and 13.0%, respectively, which reinforce their position as industry leaders. These figures indicate a highly concentrated market with winner-take-all dynamics. Cluster-based development enables large publishers to integrate resources, build brand clusters, and establish strong advantages in content quality, market influence, and digital platform development, profoundly shaping scholarly communication and evaluation systems.

Cluster development yields several benefits through resource consolidation: reduced operating costs, improved publishing efficiency, and enhanced user experience and knowledge services *via* unified digital platforms. Flagship journals within clusters can support new titles through resource sharing, rapidly boosting overall impact and creating an academic "siphoning"

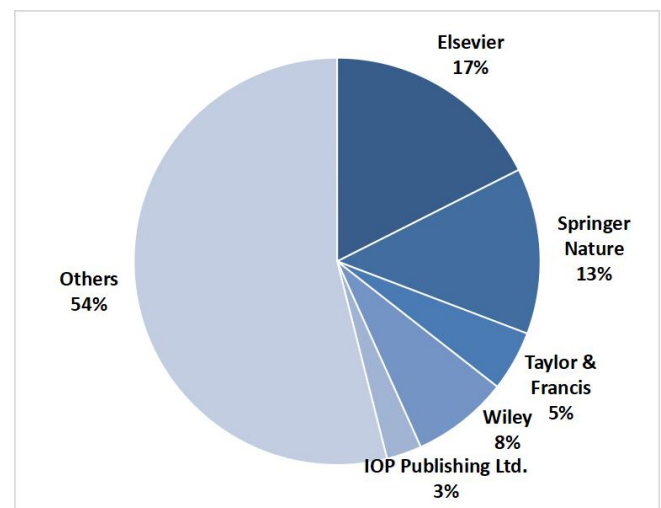


Figure 2. Major publishers' physics journal shares in 2024.

effect.^[21] Moreover, large-scale clusters enable experimentation with diversified business models (*e.g.*, open or hybrid access), strengthening resilience and innovation capacity in response to market and technological changes.^[3]

China's scientific publishing sector is actively promoting cluster construction through policy guidance and pilot initiatives. At the national level, the second phase of the "Excellence Action Plan of China Scientific, Technical and Medical Journals" explicitly lists "cluster (group) pilot" as a key subproject, aiming to support scaled publishing organizations in resource integration and platform strengthening to attract high-quality manuscripts and enhance international influence.^[22–29] Regionally, areas such as Beijing have launched the "Capital Science and Technology Journals Excellence Initiative", directly funding pilot cluster projects to address the limitations of the "single-journal" model.^[30] These efforts encourage cross-region and cross-department integration to form specialized academic journal clusters. Such measures reflect a strategic shift in Chinese scientific publishing from cultivating individual journals to fostering ecosystems and holistic improvement, seeking to enhance international competitiveness and sustainability through concentrated publishing platforms and cluster systems.

Preliminary assessments of these cluster-building initiatives indicate promising early outcomes. A survey-based analysis of 63 journal clusters in China reports progress in areas such as resource integration, the enhancement of digital platforms, and some success in attracting international submissions.^[31] However, challenges remain, including the need for deeper operational integration among member journals, sustainable funding models beyond initial government support, and the devel-

Table 4: Major publishers' physics journal holdings and shares from 2022 to 2024

Publisher	2024 physics journals	Share (%)	2023 physics journals	Share (%)	2022 physics journals	Share (%)
Elsevier	429	17.6	421	17.6	402	17.2
Springer Nature	321	13.2	320	13.4	313	13.4
Taylor & Francis	118	4.8	116	4.9	117	5.0
Wiley	187	7.7	152	6.4	150	6.4
IOP Publishing Ltd.	68	2.8	63	2.6	60	2.6
Total	1123	46.0	1072	44.9	1042	44.5

opment of globally competitive editorial and marketing strategies. These early experiences suggest that although policy-driven clustering can accelerate structural reform, long-term success will depend on adaptive governance, professionalized management, and strategic international partnerships.

CONCLUSION

The international physics journal publishing ecosystem is undergoing structural realignment driven by expanding OA, deepening interdisciplinarity, and publisher clustering. These trends interact and reinforce one another: OA accelerates dissemination and access, interdisciplinary journals channel cutting-edge research across fields, and publisher clusters leverage scale and platforms to shape market dynamics. Although these developments present opportunities for more efficient, equitable, and problem-oriented scholarly communication, they pose challenges such as balancing financial sustainability with OA goals, ensuring editorial fairness across disciplines, and maintaining diversity amid market concentration. For China, participating in global OA initiatives, investing in interdisciplinary editorial capacity, and piloting cluster-based publishing are promising strategies for world-class journals with national characteristics. Continued policy innovation, technical investment, and international collaboration are essential to navigate this evolving landscape and strengthen the global influence of physics scholarship.

DECLARATIONS

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Author contributions

Guo D: Propose the research framework, draft and revise the manuscript. Jin RQ, Liu Y, Xiong JX: Collect materials. Wang XF: Propose the thesis topic, revise the manuscript. All authors have read and approved the final version of the manuscript.

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The authors have no conflicts of interest to declare.

Use of large language models, AI and machine learning tools

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Data availability statement

No additional data.

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