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Study on the Differences Between Journal Papers and Conference Papers in the Frontier of Basic Research: Taking the Terahertz Field as an Example

Liu Hao[1], Chen Yunwei[2], Zhang Biao[3]

[1]*liuh@clas.ac.cn*, [2]*chenyw@clas.ac.cn*, [3]*zhangbiao231@mails.ucas.ac.cn*
National Science Library(Chengdu), Chinese Academy of Sciences, Chengdu, Sichuan (China)

Abstract

Analyzing the discrepancies in the content of journal papers and conference papers in the frontier of basic research is beneficial for a comprehensive understanding of the characteristics and patterns of basic research development. Retrieve data from the Web of Science (WoS) database in the frontier of basic research. Employ a comprehensive approach using bibliometrics, social network analysis, and text mining methods to compare the differences in content between journal papers and conference papers.Explore aspects such as publication trends, paper contributions, and thematic evolution to analyze the disparities in the presentation of information between journals and conference proceedings.Terahertz crystallography, terahertz optical materials, and terahertz optoelectronic radiation tend to have theoretical research outcomes published more frequently in journal papers. On the other hand, terahertz high-frequency communication and application systems, terahertz communication technology, terahertz detectors, terahertz imaging, and measurement technology lean towards technical and applied research, with a preference for publication in conference papers.The research findings of this study uncover differences in literature characteristics and research topic across journal papers and conference paperss. This contributes to a more nuanced interpretation of the patterns in basic research development, ultimately enhancing the accuracy of identifying disruptive technologies and other related aspects in future investigations.

Introduction

In the realm of cutting-edge foundational research, we find the epitome of scientific inquiry marked by disruptive innovation, interdisciplinary collaboration, and the juxtaposition of high risks and high rewards. Typically, outcomes in foundational research manifest in two primary forms: journal papers and conference papers. Journal papers often emphasize in-depth exploration of research questions, emphasizing the completeness, systematic nature, and scholarly qualities of proposed solutions. These articles cover a broad range of content, exhibiting enduring influence and dissemination effects within academic circles and the collective intellectual reservoir of humanity (Zhou, Y, 2013). On the other hand, conference papers tend to prioritize swift responses to research questions and inspire innovative thinking. Their focus lies in discovering new research directions and breakthroughs within the shortest possible time frame, proving invaluable for the rapid updating and expansion of knowledge structures in a particular field.

Small teams tend to prefer citing older and less influential papers, whereas larger teams are more inclined to cite the latest cutting-edge research, providing a new perspective for a comprehensive understanding of disruptive innovation (Wu et al., 2019). To further explore the evolutionary characteristics of the foundational research field in terms of publications, institutional entities, and research topics, this

paper employs a comprehensive approach incorporating bibliometrics, network analysis, and text mining methods. Firstly, it analyzes publication trends. Secondly, it utilizes organizational relationship network similarity to analyze the contribution of two types of publications. Thirdly, based on the evolution analysis of technical topics, it examines the distribution of different research topics across the two types of publications. Through this analysis, the paper reveals differences in literature characteristics and research topic across journal papers and conference paperss. This contributes to a more detailed interpretation of the patterns in basic research development and enhances the accuracy of identifying disruptive technologies and other related aspects in future investigations.

Literature review

The current status of research in the frontier areas of basic research

Since (Bush, 2020)proposed the linear development model from basic science to applied science and then to technological innovation, basic research has been the cornerstone of technological innovation for nearly a century. (Stokes, 2011) divided scientific research into four modes and proposed the dual-track model of basic science and technological innovation. (Narayanamurti & Odumosu, 2016) established the invention-discovery cycle model. (J. Chen et al., 2004) argued that the original innovation in basic research is the highest level of all innovations. In addition to discussing the concept of basic research and its relationship with innovation activities, researchers have also focused on exploring the theory of basic research. This includes the classification of basic research, the relationship between basic research and government support, and the activities of various entities involved in basic research. There has been less systematic discussion about the construction of the environment for basic research, as well as the interactive relationship between the subjects of basic research and the environment.

Over the years, bibliometrics and scientometrics methods have played a crucial role in the identification of frontier advances and strategic policy analysis in the field of basic research. Liu (2010), from the perspective of the distribution of scientific papers at the level of disciplines, countries, and institutions, analyzed the international cooperation patterns in basic research. Ma et al. (2015) based on data from the National Natural Science Foundation, proposed a comprehensive competitiveness index for basic research. They conducted a comparative analysis of the competitiveness of provincial-level regions in basic research in China and examined its changes over time. Chen et al. (2017), using three indicators - "activity index," "attraction index," and "efficiency index" - constructed a "comprehensive research capability index." They applied these indicators to compare and characterize the relative positions and competitive patterns of various countries in basic research in the field of science and technology. Zhang et al. (2018), based on the global overall research trends and representative research units, proposed indicators for the analysis of the competitive situation in basic research. The indicators covered strategic positioning, paper output, talent structure, and research patterns.

The current status of research on the differences in impact between journal papers and conference papers

Journals and conference papers, as two essential types of scientific literature, exhibit notable differences in publication cycles, document formats, and other aspects. Journal papers are publicly disseminated, and their academic levels, publication frequencies, and paper quantities are relatively stable. On the other hand, conference papers come in various publication formats, with significant variations in academic quality. However, in fields like computer science, communication, and others (such as IEEE top conferences), conference papers often demonstrate notable advancements and breakthroughs, drawing considerable attention from numerous peers in the respective fields. Given these distinctions in research outputs, scholars have extensively discussed the differences in influence between the two.

Some scholars argue that the academic impact of journal papers is higher than that of conference papers. Garvey (2014), in their analysis of the process of scientific literature production, considers conference papers as manuscripts for journal papers and suggests that the academic value of conference papers is lower than that of journal papers. Lisée et al. (2008), through bibliometric analysis of conference papers, find that the citation rate of conference papers is lower than that of journal papers. Wolek & Griffith (1974) point out that conference papers tend to be biased towards engineering and applied fields, suggesting their relatively lower "academic content" (Godin, 1998). Freyne et al. (2010), using the journal citation indicator from Web of Science as a measure, analyze and indicate that papers published in top conferences have a similar impact to those published in moderately ranked journals. Such studies mainly assert that scholars participate in academic conferences to share preliminary research results with peers, seeking feedback to refine subsequent research, ultimately leading to the successful publication of research outcomes in academic journals. Therefore, the impact of conference papers cannot be equated with that of journal papers.

Some scholars argue that the academic impact of conference papers is higher than that of journal papers, particularly in the field of computer science. Chen & Konstan (2010) point out that if a conference has a low acceptance rate, the citation frequency of papers published in that conference is similar to that of journal papers. Vrettas & Sanderson (2015) further indicate that the citation rate of papers from top computer science conferences is higher than that of journal papers, but the difference in citation rate between papers from mid to low-ranked conferences and journal papers is not significant. This kind of research primarily asserts that conference papers represent the final research outcomes and that conferences can replace certain engineering-related journal publications (Goodrum et al., 2001). It is suggested that there is no need for re-publication in journals, but this perspective is rooted in discussions among computer scientists and may not be universally applicable to other disciplinary areas.

Additionally, some scholars analyze the impact of the two types of literature from the perspective of the publication diffusion of journal and conference papers. Miguel-Dasit et al. (2006) suggest that journal papers originating from conferences are usually of high quality and more likely to receive high citations. In a study among

computer science scholars (Bar-Ilan, 2010), approximately 25-33% of CS-related conference papers were subsequently published in journals. Similar conversion rates from conferences to journals (30%) were reported in the field of computer vision publications (Eckmann et al., 2012). These conversion rates are lower than those in the medical field (Miguel-Dasit et al., 2007) but comparable to those in the field of information metrics (Aleixandre-Benavent et al., 2009). González-Albo & Bordons (2011) argue that the transition from conference to journal papers can be explained from the perspective of authors seeking to enhance research visibility and impact. Journal papers often have a greater potential to attract more citations than conference papers.

Domain Data and Research Framework

Domain Data

In recent years, terahertz technology, as a typical representative in the forefront of foundational research, operates at frequencies higher than microwaves and lower than infrared radiation. The energy levels fall between electrons and photons, giving it numerous unique properties compared to electromagnetic waves at other frequencies. In areas such as communication, radar, electronic warfare, electromagnetic weaponry, medical imaging, and security checks, terahertz technology holds tremendous potential for applications. It has been recognized by the United States as one of the 'Top Ten Technologies Changing the Future World.' Currently, terahertz technology is gaining increasing attention worldwide due to its distinctive capabilities and broad prospects. It is internationally acknowledged as a contested area in high-tech fields, and its research and applications are considered to have significant strategic implications for future warfare and national security (Qian, 2022).

Based on this, the present study utilizes the Web of Science (WoS) Core Collection database as the data source, using terahertz field papers as an example to conduct a comparative analysis of the differences between journal papers and conference papers in the field of basic research. The literature search formula is TS=("terahertz*" OR "terahertz*"), refining the Web of Science index to SCI-E, ESCI; refining the publisher to IEEE; the time range is from January 1, 2004, to December 31, 2023, with the search conducted on June 9, 2023. The results were downloaded in "plain text" format, and after removing duplicates, a total of 44,683 papers were obtained, including 33,057 journal papers and 11,626 conference papers.

Research Framework

This study, depicted in Figure 1 as the main research framework, analyses the differences between journal papers and conference papers at the forefront of basic research from three perspectives: publication trends, paper contributions, and thematic evolution.

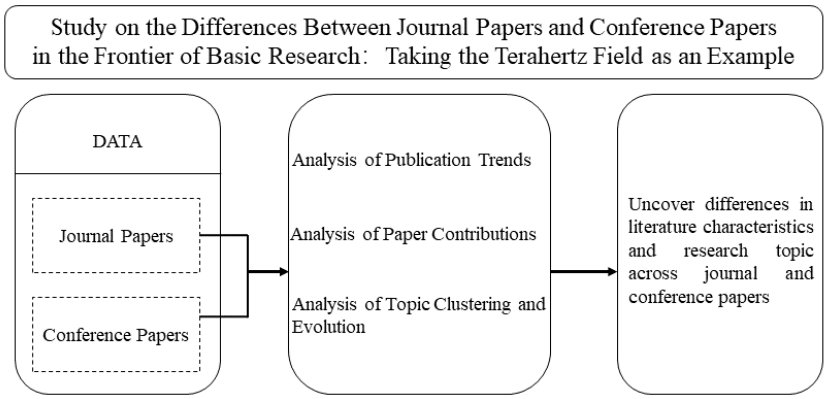


Figure 1. Research framework diagram.

Analysis Methodology for Paper Contributions

To effectively analyze the contributions of journal and conference paper collections to the total paper collection, this paper adopts an analysis approach from the perspective of the similarity of institutional relationship networks (co-occurrence network, citation network). This approach aims to present the comparison results of paper contributions more comprehensively and accurately. The coupling of institutional relationship networks is manifested in the coupling of nodes and structural coupling between networks. Node coupling in institutional relationship networks reveals the institutional associations formed by the correspondence between network nodes, while structural coupling arises from the consistency of network edges. To measure the similarity between institutional relationship networks, we propose a new method that evaluates their node coupling strength and structural coupling strength. The node coupling strength of institutional relationship networks is calculated based on the similarity of PageRank values of coupled nodes in the two networks, while the structural coupling strength is calculated based on the similarity of Weight values of coupled edges in the two networks.

Methodology for Theme Identification

Based on the overall paper collection in the terahertz field, topic clustering is performed using the titles and abstracts of the papers. The data undergoes preprocessing, including standardizing the case, removing punctuation, part-of-speech tagging, lemmatization, and eliminating stop words. Subsequently, the optimal number of topics is determined based on the topic perplexity method and LDAvis (Blei et al., 2003). The matching probability values between papers and topics are then exported to identify the topics to which different papers belong, and names are assigned to different topics. Finally, based on the identification results, the literature volume of different topics over time is analyzed to further conduct a topic evolution analysis.

Empirical Analysis

Analysis of Publication Trends

The publication trend is illustrated in Figure 2. From 2004 to 2023, the global terahertz field showed a rapid growth in the number of publications, with a noticeable increase in 2013, surpassing 2300 papers globally. Journal papers also exhibit a growing trend, closely aligning with the overall publication trend. However, the growth trend of conference papers is not as pronounced and consistently remains below 1000 papers. Particularly around 2020, journal papers continue to show growth, while conference paper publications experience a declining trend.

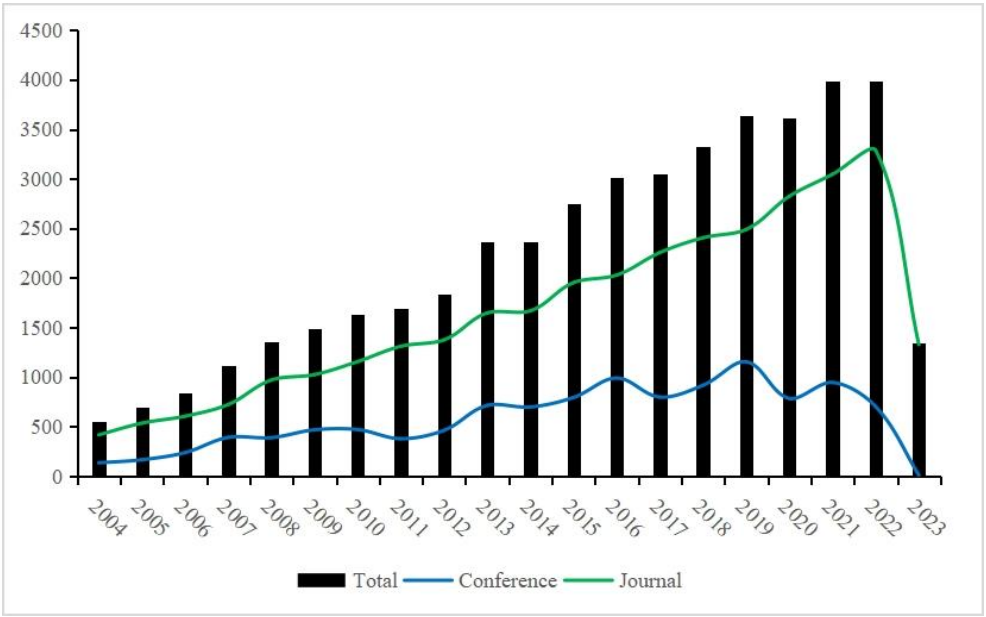


Figure 2. Publication trends of terahertz field journal papers and conference papers.

Figure 3 presents the publication output of the top 10 countries in the field of terahertz research. China has published 14,080 papers, while the United States has published 8,317 papers, indicating that China significantly surpasses the United States. In 2004, the United States had the highest publication output, with China ranked 6th. However, China's publication output started to increase annually and surpassed the United States in 2014, becoming the world's leading country in terms of terahertz research publications. Since 2014, China has consistently maintained its position as the top contributor with a significantly higher publication output than the United States.

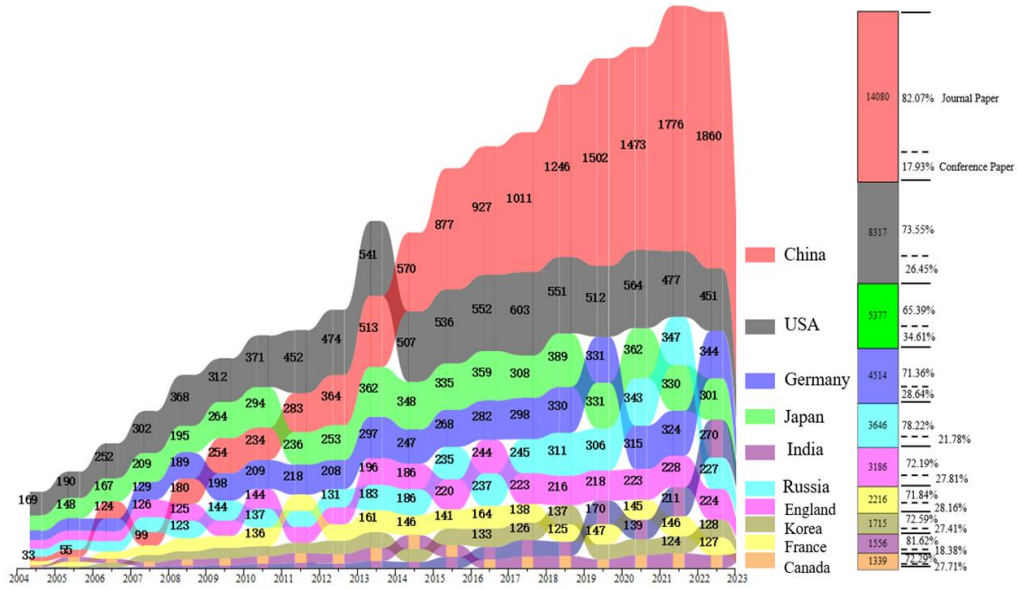


Figure 3. Trend chart of publication output in the top 10 countries in terms of publication quantity.

Although China and the United States have a similar output in conference papers, conference papers only account for 17.93% of the total. It is worth mentioning that among the top 10 countries with the highest publication output, China, India, and Russia, as developing countries, have a higher proportion of journal papers compared to the other seven developed countries. China and other developing countries tend to publish more journal papers in the field of terahertz research compared to countries like the United States.

Comparison of Contributions between Journal Papers and Conference Papers

This study conducted separate analyses for the overall period and sub-periods, namely 2004-2008, 2009-2013, 2014-2018, and 2019-2023. The analyses focused on the co-occurrence network and citation network among institutions in the overall dataset, journal paper dataset, and conference paper dataset. Tables 1 and 2 present the findings.

Based on the co-occurrence network, it was observed that the number of nodes and edges in the journal paper dataset is very close to that of the overall dataset, while the number of nodes and edges in the conference paper dataset is relatively smaller. This indicates that institutional collaborations in the field of terahertz research are predominantly reflected in journal papers, whereas collaborations in conference papers are relatively weaker. This pattern remained consistent across the four time periods.

Additionally, the similarity between the co-occurrence network of journal papers and the overall dataset was found to be 0.98365, which is very close to 1. On the other hand, the similarity between the co-occurrence network of conference papers and the overall dataset was 0.75777, lower than the similarity value for journal papers. This

similar pattern was also observed across the four time periods. These findings suggest that journal papers exhibit a higher similarity to the overall dataset in terms of institutional collaborations in the co-occurrence network. Journal papers make a greater contribution and hold higher value compared to conference papers in the co-occurrence network of institutions.

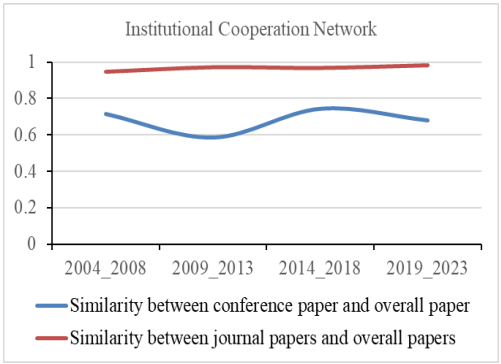
Table 1. Overview and similarity of co-occurrence networks in institutions.

Net	Style	All Time	2004-2008	2009-2013	2014-2018	2019-2023
Total dataset co-occurrence network in institutions	Number of nodes	10197	1502	2862	4529	6053
	Number of edges	62685	4129	14047	22901	31959
Journal paper collection co-occurrence network	Number of nodes	8883	1276	2441	3875	5500
	Number of edges	57247	3520	12604	20478	29833
	Similarity to the total dataset	0.98365	0.94663	0.97305	0.96915	0.98464
Conference paper collection co-occurrence network	Number of nodes	3522	554	1057	1791	1733
	Number of edges	10626	952	2342	4522	4103
	Similarity to the total dataset	0.75777	0.71610	0.58543	0.74481	0.68040

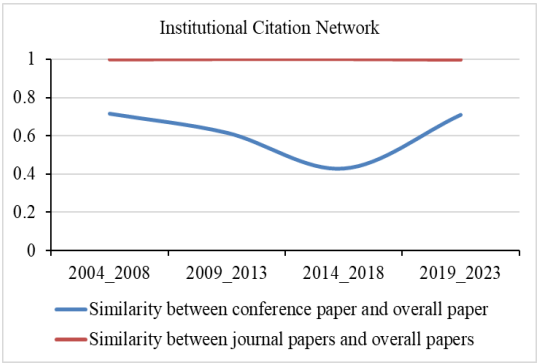
Table 2. Overview and similarity of citation networks in institutions.

Net	Style	All Time	2004-2008	2009-2013	2014-2018	2019-2023
Total dataset citation network in institutions	Number of nodes	9150	1176	2863	5096	8212
	Number of edges	533257	14158	74550	195149	383699
Journal paper collection citation network	Number of nodes	8923	1139	2846	5087	8003
	Number of edges	527351	13920	74272	194908	377791
	Similarity to the total dataset	0.99910	0.99799	0.99987	0.99993	0.99663
Conference paper collection citation network	Number of nodes	2758	241	289	273	2585
	Number of edges	19813	656	793	684	18043
	Similarity to the total dataset	0.71876	0.71660	0.61693	0.42938	0.71088

Based on the four designated periods, the comparison of the similarity trends between journal papers and conference papers in the co-occurrence networks with the total dataset is presented. Additionally, the similarity trends of journal papers and conference papers in the institutional citation networks with the total dataset are also compared, as shown in Figure 4. In both institutional collaboration networks and institutional citation networks, the similarity of journal papers to the overall papers remains close to 1, consistently higher than the similarity of conference papers to the overall papers. This indicates that, whether in institutional collaboration networks or institutional citation networks, journal papers contribute more significantly compared to conference papers. The similarity of conference papers to the overall papers in institutional collaboration networks fluctuates but consistently maintains around 0.7. On the other hand, the similarity of conference papers to the overall papers in institutional citation networks experienced a significant decline from 2014 to 2018, suggesting that the contribution of conference papers to institutional citation networks is relatively weaker compared to institutional collaboration networks.



The comparative trend of similarity between journal papers and conference papers in institutional co-occurrence networks



The comparative trend of similarity between journal papers and conference papers in institutional citation networks

Figure 4. The similarity changes in institutional collaboration networks and institutional citation networks.

Topic Clustering and Evolution Analysis

Analysis Methodology for Paper Contributions

Calculate the perplexity with the change in the number of topics, as shown in Figure 5 (Left). Identify the inflection point as the optimal number of topics, which is 8. From Figure 8 (Right), it can be observed that the distribution of each topic is sparse with fewer crossovers, indicating a good result in topic identification. The results of topic clustering are shown in Table 3.

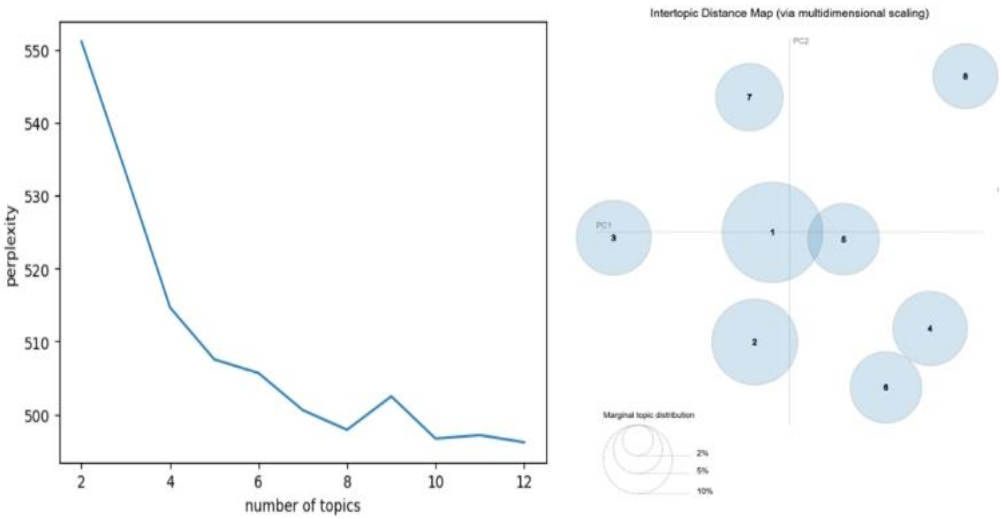


Figure 5. Selection of a number of topics.

Table 3. Overall dataset topic clustering results in the Terahertz domain.

Topic	Topic Concepts	Total number	Journal	Conference
Topic 1: Terahertz detectors	Emphasis is placed on terahertz detector technologies, including detectors based on GaAs materials, photodetectors, and detectors operating in room temperature and resonance modes.	5204	3445(66%)	1759(34%)
Topic 2: Terahertz crystallography	Focus on crystallographic research in the terahertz range, including studying crystal structures, domain distribution, characteristics of solid materials, and phase transitions at different temperatures.	3378	2852(84%)	526(16%)
Topic 3: Terahertz communication technology	Main focus on communication technology in the terahertz range, including terahertz antenna technology, waveguide technology, filter technology, and integrated circuit design.	4676	3076(66%)	1600(34%)
Topic 4: Terahertz optical materials	Research optical materials in the terahertz range, including materials based on graphene, surface plasmon resonance, multilayer structures, etc. These materials are used for applications such as absorption, transmission, modulation, and sensing of terahertz waves.	9108	7503(82%)	1605(18%)
Topic 5: Terahertz spectroscopy	Focus on spectroscopic techniques in the terahertz range, including using terahertz waves for time-domain spectroscopic analysis, measurement of refractive index and absorption coefficient of materials, research in the field of thin films, exploration of dynamic processes, and analysis of transmission and scattering characteristics.	3393	2588(76%)	805(24%)
Topic 6: Terahertz optoelectronic radiation	Focus on radiation phenomena and generation mechanisms in the terahertz range, including radiation from terahertz fields, wave generation, nonlinear optical effects, pulse excitation, and interactions between terahertz light and electrons.	9562	7726(81%)	1836(19%)
Topic 7: Terahertz high-frequency communication and application systems	Focus on communication system technologies in the terahertz range, including high-frequency and high-bandwidth communication systems, signal modulation, transmission technologies, and exploring applications of terahertz waves in the spatial domain.	3800	2114(56%)	1686(44%)
Topic 8: Terahertz imaging and measurement technology	Focus on imaging and measurement technologies in the terahertz range, including imaging methods, resolution improvement, as well as experimental validation of detection and measurement methods, measurement accuracy, and sensitivity.	5562	3753(67%)	1809(33%)

It can be observed that the terahertz domain is divided into 8 research topics. Among them, Topic 6 and Topic 4 have a relatively high total number of papers, with 9562 and 9108 papers respectively, while the number of papers on other topics is around 4000. In terms of paper type distribution, journal papers are more prevalent in Topics 2, 4, and 6, accounting for over 80%, indicating a preference for publishing theoretical research results in journal papers. On the other hand, conference papers have a larger proportion in Topics 7, 3, 1, and 8, all exceeding 30%, especially in Terahertz High-Frequency Communication and Application Systems, with a proportion of 44.37%, far exceeding the average conference paper proportion of 26.02%. This suggests that achievements in technology and applied research are more inclined to be published in conference papers.

Topic Evolution Analysis

Based on the results of topic identification, the literature volume of different topics over time in various periods is statistically analyzed, as shown in Figure 6. Topics 1, 2, 5, and 6, while showing a slight increase in the number of publications in each period, generally maintain a relatively constant state. On the other hand, Topics 3, 4, 7, and 8 exhibit an overall significant growth trend in literature volume, indicating

an increasing attention to their research in recent years, with the output growing annually.

Moreover, in terms of absolute publication volume, Topic 6 has consistently received high attention in each period, maintaining a consistently high publication output and being one of the research hotspots. At the same time, Topic 4 shows a clear evolutionary growth trend with a substantial increase in publications, garnering increasing attention in recent years and becoming one of the most prominent research hotspots. Topics 2 and 5, with consistently lower publication volumes, have lower levels of attention. Although Topics 3 and 7 generally have a lower overall attention level, their publication volumes have been growing in recent years, suggesting the potential to become new technological research hotspots in the future.

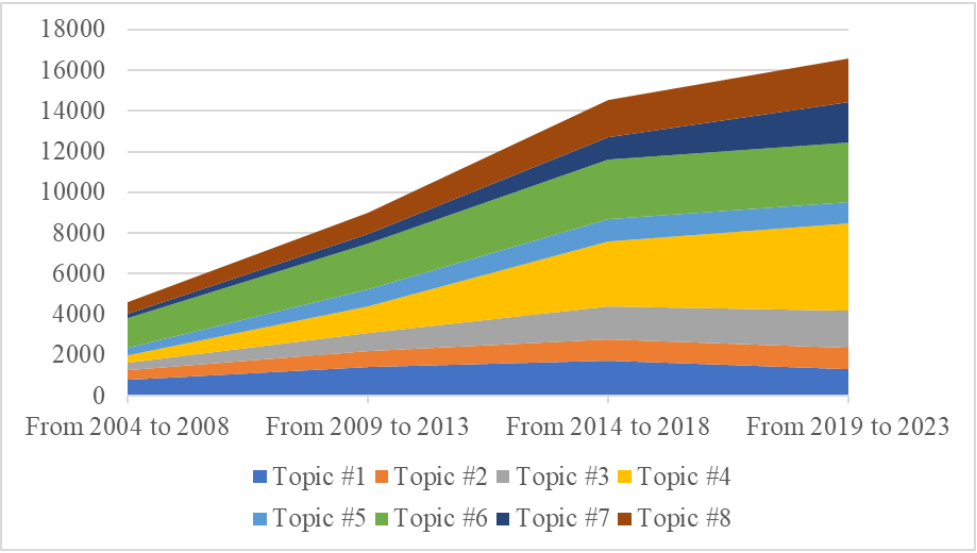


Figure 6. The evolutionary trend of the total paper collection's topic literature volume over time.

Discussion and Outlook

With the evolution of the international science and technology competitive landscape, the pursuit of cutting-edge basic research has become a focal point for major technological powers. This trend places higher demands on the innovative application of literature and information methods. To more accurately carry out the identification of disruptive technologies and frontier hotspots in the field of basic research, and to explore from a richer perspective, this study investigates the differences in published literature between journal papers and conference papers. Taking the terahertz domain as an example, the research empirically analyses the differences in publication trends, paper contributions, and topic evolution between the two types of papers. This exploration aims to further discuss the characteristics and patterns reflected in basic research papers on different types of papers .

The research results indicate that:

Over the past 20 years, the global publication volume in the terahertz domain has shown an overall increasing trend. The top 10 countries with the highest publication

volumes in the terahertz domain are China, the United States, Japan, Germany, Russia, the United Kingdom, France, South Korea, India, and Canada. China, in particular, has a significantly higher publication volume in the terahertz domain compared to other countries. Among the top 10 countries with the highest publication volumes, the proportion of journal papers from developing countries such as China, India, and Russia is higher than that of the other seven developed countries. Developing countries, including China, tend to publish more journal papers in the terahertz domain compared to developed countries like the United States.

In terms of the contributions of the two types of literature, whether in institutional citation networks or institutional co-occurrence networks, the similarity of journal papers to the overall paper collection is higher than that of conference papers. Considering that the quantity of journal papers is generally higher than that of conference papers, the domain contribution value of journal papers remains higher. Over time, the similarity of journal papers to the overall papers in both institutional co-occurrence networks and institutional citation networks is higher than the similarity of conference papers to the overall papers. In most domains, institutional collaboration is more prominent in journal papers, while institutional collaboration in conference papers is relatively weaker.

Regarding topic identification, the terahertz domain comprises 8 research topics: terahertz detectors, terahertz crystallography, terahertz communication technology, terahertz optical materials, terahertz spectroscopy, terahertz optoelectronic radiation, terahertz high-frequency communication and application systems, and terahertz imaging and measurement technology. Results inclined towards theoretical research preferentially appear in journal papers, while results leaning towards technology and applied research are more likely to be published in conference papers. Currently, terahertz optoelectronic radiation and terahertz optical materials are two major research hotspots, while terahertz communication technology and terahertz high-frequency communication and application systems are expected to become new research hotspots in the future, garnering higher research attention.

In the application of traditional literature and information methods to the identification of cutting-edge and disruptive research in basic research, there has been a greater focus on the content of large-scale datasets in the field and their internal relationships. To some extent, this approach has overlooked the mutual relationship between the characteristics of literature across different mediums and the evolving trends of research subjects. While this study has certain limitations in terms of data scale, field selection, and method choice, the research results reveal differences in the characteristics of literature across different mediums and research topics. This insight can contribute to a more detailed interpretation of the development patterns in basic research and enhance the accuracy of identifying disruptive technologies in the future.

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