

Bibliometric Analysis of Cited Sources in Physics Research at the Central University of Jammu

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Abstract

This article explores the citation practices, source preferences, collaboration trends and research focuses of physics researchers at the Central University of Jammu, through bibliometric analysis, it reveals a strong preference for journal articles, a focus on high-impact publications, collaborative authorship patterns, global institutional affiliations and diverse research interests, including advanced materials and nanotechnology. These findings offer valuable insights into the university's research dynamics and its standing in the global physics research community.

Keywords: Citation Behaviour, Citation Analysis, Physics Research, Central University of Jammu, Keyword Analysis, Research Themes, Biblioshiny

Introduction

Bibliometric analysis is a method used to study the patterns and trends in scientific research (Pritchard, 1969). By analysing academic publications, citations and other relevant metrics, it provides insights into the dynamics of scientific inquiry, collaboration networks and the evolution of various disciplines. This approach helps identify the most influential works and authors, as well as emerging areas of research, thereby facilitating a deeper understanding of the scientific landscape (Das et al., 2021; Deveci, 2023; Jalal & Koner, 2021; Mahemei & Bhatt, 2020; Schlembach, 2023). This study focuses on the citation behaviour of Physics researchers at the Central

University of Jammu, aiming to uncover the nature and scope of sources that shape the research outputs in this academic enclave.

Physics is a rapidly evolving field of study that encompasses a broad spectrum of sub-disciplines, from classical mechanics to quantum physics and astrophysics. Due to its inherent complexity and continuous discovery of new phenomena, it remains at the forefront of scientific research. Bibliometric analysis is an effective method of uncovering trends and collaboration patterns within this field (Scheidsteger et al., 2021). The Central University of Jammu (CUJ) has a vibrant community of Physics researchers, making it an interesting case study for bibliometric analysis. Analysing the citation behaviour of these researchers can reveal the core and emerging areas of research focus within the university's Physics department. It can also provide insights into the intellectual foundations that influence current research directions, including the role of seminal works and leading journals. Understanding citation patterns can help identify collaborative networks and affiliations, both domestic and international, which can elucidate the university's integration into the global physics research community.

The purpose of this bibliometric analysis is not only to explore the map the citation landscape but also to decode the underlying narratives that drive research in Physics at the CUJ. By doing so, this study aims to contribute to a better understanding of the institution's research culture, potential areas for growth and its position within the wider scientific discourse. This analysis can provide researchers,

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policymakers and academic leaders with insights that can foster innovation and excellence in scientific research.

Literature Review

The review of related literature explores prior studies that have applied bibliometric analysis to understand citation behaviour, collaboration patterns and research trends within the broader field of physics and similar disciplines. A considerable portion of bibliometric research in the field of physics has been focused on the mapping of the research landscape, identifying core areas of research and understanding collaboration networks. For example, research studies conducted by Ratnavelu et al. (2023); Leydesdorff and Zhou (2005) have employed citation analysis to identify influential works and emerging research frontiers in physics, illustrating the dynamic evolution of the field. These studies have highlighted the crucial role of bibliometric analysis in revealing the structure of scientific disciplines and the interconnectedness of research communities.

Research on citation behaviour, such as the seminal work by Garfield (1955) and later studies by Bornmann and Daniel (2008), has explored the motivations behind citations and their implications for measuring research impact. These studies reveal a complex landscape where citations serve not only as a measure of scholarly influence but also as a mechanism for scientific communication, linking current research with the foundational knowledge base. The study of collaboration patterns has gained prominence, with researchers like Katz and Martin (1997) and Wuchty et al. (2007) examining the increasing trend towards collaborative research in science. These studies highlight the benefits of collaboration, including enhanced research productivity and innovation, while also identifying the challenges of coordinating across diverse research teams and disciplines. With the increasing emphasis on interdisciplinary research, studies have also investigated how citation patterns reflect the integration of diverse scientific domains. Rafols and Meyer (2010) and Porter and Rafols (2009) have contributed to understanding how interdisciplinary research influences citation behaviour, suggesting that cross-disciplinary studies tend to receive citations from a wider range of fields, albeit potentially

facing challenges in gaining recognition within highly specialised communities. Muruli and Harinarayana examined the 'citation behaviour' of physics and astronomy researchers from Indian central universities in the Western Himalayan region.

The present study builds on the work of previous studies by applying bibliometric analysis to the physics research community at the CUJ. By examining a specific institutional context, this study contributes to a deeper understanding of citation behaviour, collaboration networks and research trends in physics. By highlighting the unique aspects of citation behaviour and collaboration within the context of a rapidly developing research institution in India, this study adds to the existing literature and provides valuable insights into the dynamics of scientific research at the intersection of institutional and disciplinary boundaries.

Research Questions

The following research questions are used to guide the scope and focus of the study:

RQ1: Which types of scholarly documents are predominantly cited by physics researchers at the CUJ?

RQ2: Which journals are most frequently cited by physics researchers at CUJ?

RQ3: Which institutional affiliations and countries are most represented in the works cited by physics researchers at the CUJ?

RQ4: What authorship patterns in cited works reveal about collaboration trends among physics researchers?

RQ5: Based on keyword analysis, what are the principal research themes and technological focuses of physics research at the CUJ?

Materials and Methods

This section outlines the methodological framework employed to conduct the bibliometric analysis of sources cited by the researchers. It details the data collection process, including the selection criteria and time span, the bibliometric tools and software utilised for analysis.

Scope and Limitations

This bibliometric analysis is confined to the examination of scientific articles and reviews published by physics researchers at the CUJ. The selection criteria were designed to ensure that the study includes a comprehensive dataset relevant to the research focus. The study period ranges from 2012 to 2021, covering literature published and indexed in the Scopus database. This timeframe ensures that the analysis reflects recent research trends and citation behaviours within the physics community at the university.

Data Source

For this study, Scopus was chosen as the main data source due to its comprehensive coverage of peer-reviewed literature across various disciplines, including physics. The database is well-known for its reliable indexing, which makes it easier to retrieve a wide range of document types and ensures that the data collected for analysis is relevant and of high quality. A total of 3,733 sources were obtained in BibTex file format and carefully analysed using bibliometric tools and software.

Bibliometric Tools and Software

The study employs R Studio, a comprehensive tool for statistical computing and graphics, which serves as the foundation for conducting advanced bibliometric analysis. R Studio enables the handling of large datasets and the execution of complex statistical operations, within R Studio, the Bibliometrix and Biblioshiny packages were utilised for bibliometric analysis. These packages offer a suite of functions for data processing, analysis and visualisation, supporting the examination of citation patterns, collaboration networks and trends in the scientific literature (Aria & Cuccurullo, 2017).

Data Analysis and Interpretation

Document Types Analysis

The citation practices of physics researchers at the CUJ as shown in Table 1 exhibit a diverse use of scholarly communications, primarily focusing on journal articles

(77.52%). This preference highlights the crucial role of articles in disseminating new research findings within the physics field. Conference papers (4.80%) emphasise the significance of academic conferences as venues for presenting early-stage results and fostering scholarly interactions. Review articles (7.02%) hold value for consolidating and evaluating the current research landscape on specific topics, indicating the importance of comprehensive overviews to the community. Books and book chapters (0.27%/0.24%) are relatively less cited, suggesting that researchers prefer the more immediate and detailed research findings typically presented in articles and conference proceedings. Some citations (9.62%) fall into undefined or miscellaneous categories. Overall, this analysis of citation behaviour among physics researchers at the CUJ highlights the primacy of peer-reviewed journal articles in disseminating research and reflects the dynamic and multi-faceted nature of knowledge sharing and development within the field of physics. The emphasis on conference papers and review articles further illustrates the community's engagement with both the cutting-edge and the foundational aspects of their discipline.

Table 1: Distribution of Document Types Cited by Physics Researchers

Sr. No.	Document Type	No. of Documents	%
1	Article	2894	77.52
2	Book	10	0.27
3	Book Chapter	9	0.24
4	Conference Paper	179	4.80
5	Editorial	5	0.13
6	Letter	6	0.16
7	Note	4	0.11
8	Retracted	1	0.03
9	Review	262	7.02
10	Short Survey	4	0.11
11	Undefined	359	9.62
Total		3733	100

Citation Source Analysis

Table 2 displays the top 10 journals that the physics research community at the CUJ cites the most. This table highlights the journals that have the most impact based on citation frequency, geographical distribution of publishers,

h-index, SCImago Journal Rank (SJR) Quartile ranking, cite score and open access status. The analysis shows that the Physics researchers at CUJ is primarily focused on nuclear physics and fundamental research, as it mainly cites journals such as “Physical Review C,” “Nuclear Physics A,” and “Physical Review Letters.” The Journal data was derived from SJR metrics were recorded in

February 2024. The results show that the researchers prefer high-impact, Quartile 1 journals, primarily from the United States and the Netherlands, reflecting the global and interdisciplinary nature of physics research pursued at the university. Additionally, the variation in open access availability among these top-cited journals highlights the diverse accessibility of research outputs.

Table 2: Top Cited Journals in Physics Research

Rank	Journal	Freq	Country	Publisher	H-Index	SJR	Quartile	Cite Score	Open Access
1	Physical Review C	249	United States	American Physical Society	229	1.31	1	5.7	No
2	Nuclear Physics A	139	Netherlands	Elsevier	170	0.52	2	3.4	No
3	Physical Review Letters	118	United States	American Physical Society	674	3.12	1	17	Yes
4	Sensors and Actuators B: Chemical	95	Netherlands	Elsevier	223	1.48	1	14.6	No
5	Nuclear Data Sheets	77	United States	Academic Press Inc.	66	1.43	1	9.4	No
6	Applied Physics Letters	56	United States	American Institute of Physics	466	1.04	1	6.4	No
7	Journal of the American Chemical Society	55	United States	American Chemical Society	674	5.95	1	25.7	Yes
8	Applied Surface Science	46	Netherlands	Elsevier	219	1.19	1	12.7	No
9	Journal of Applied Physics	42	United States	American Institute of Physics	341	0.71	2	5.1	No
10	ACS applied materials & interfaces	38	United States	American Chemical Society	284	2.18	1	15.7	Yes

Note: Metrics based on Scopus® data as of April 2023, retrieved from SJR on 28th Feb 2024.

Co-Citation Network of Sources

The analysis of the Co-Citation Network of sources (Fig. 1) cited by physics researchers at the CUJ reveals the importance of critical journals within the field. The betweenness centrality metric shows that “Physical Review Letters” and “Physical Review B” plays a critical role in linking different research areas. On the other hand, the closeness centrality and PageRank metrics

show the wide influence and trust in journals such as “The Journal of the American Chemical Society and “Science.” The network’s division into clusters suggests a dual focus on foundational physics and interdisciplinary research involving chemistry and materials science. This indicates a vibrant research environment at the university, characterised by a blend of in-depth physics exploration and cross-disciplinary studies, fostering innovation and discovery across fields.

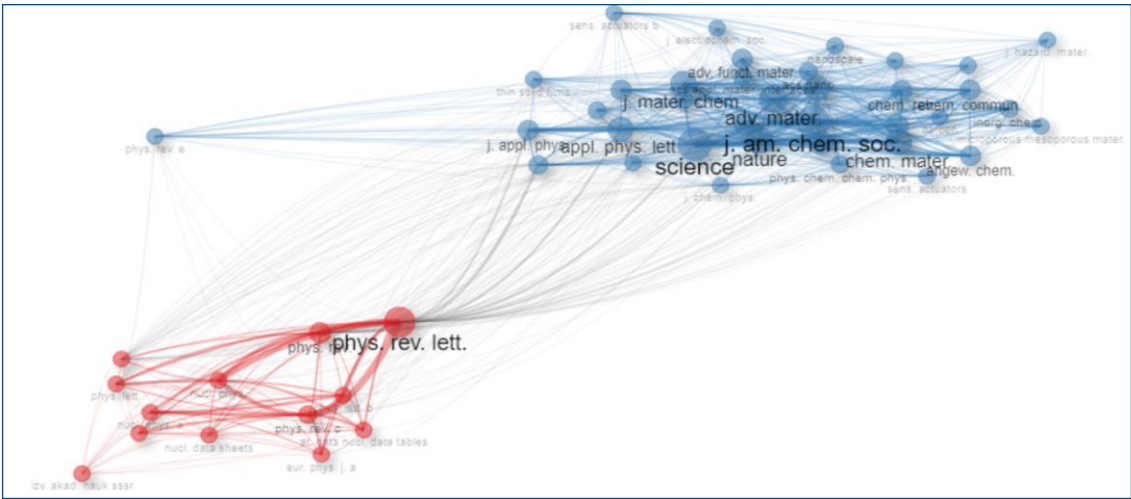


Fig. 1: Co-Citation Network Map of Frequently Cited Sources

Table 3: Authorship Patterns Among Cited Physics Research Works

No. of Authors	Article	%	BBC	%	CP	%	Reviews	%	Other Types	%	Total	%
1	199	6.88	4	21.05	15	8.38	29	11.07	146	38.52	393	10.53
2	383	13.23	9	47.37	32	17.88	56	21.37	96	25.33	576	15.43
3	465	16.07	2	10.53	42	23.46	65	24.81	47	12.40	621	16.64
4	456	15.76	3	15.79	37	20.67	41	15.65	33	8.71	570	15.27
5	356	12.30	0	0.00	21	11.73	25	9.54	21	5.54	423	11.33
6	264	9.12	1	5.26	11	6.15	14	5.34	16	4.22	306	8.2
7	215	7.43	0	0.00	5	2.79	11	4.20	7	1.85	238	6.38
8	156	5.39	0	0.00	5	2.79	7	2.67	5	1.32	173	4.63
9	88	3.04	0	0.00	2	1.12	8	3.05	3	0.79	101	2.71
10	60	2.07	0	0.00	0	0.00	2	0.76	2	0.53	64	1.71
More than 10	252	8.71	0	0.00	9	5.03	4	1.53	3	0.79	268	7.18
Total	2894	100	19	100	179	100	262	100	379	100	3733	100

Note: BBC- Book & Book Chapter, CP- Conference Papers, Other Types - Editorial, Letter, Note, Short Survey, Undefined etc.

Authorship and Collaboration Analysis

The analysis of authorship patterns (Table 3) in the citations by physics researchers at the CUJ reveals a strong trend towards collaborative research, with single-authored articles forming a minor portion (10.53%) of the total citations. The data highlights the preference for small to medium-sized author teams, particularly in the 2-4 author range. It indicates a balance between collaborative diversity and manageable team sizes.

Large-scale collaborations, especially in experimental and high-energy physics, are also notable, with papers having more than 10 authors representing 7.18% of citations. Interestingly, single-author contributions are more prevalent in book chapters and reviews, indicating the continued importance of individual expertise in these formats. Conference papers and other documents show varied authorship patterns, with a significant presence of single-authored and small team contributions.

Table 4: Top 10 Institutional Affiliations in Cited Works

Sr. No.	Affiliation	Articles	Country
1	University of California	95	United States
2	University of Tennessee	61	United States
3	Michigan State University	53	United States
4	Tsinghua University	52	China
5	Argonne National Laboratory	47	United States
6	Central University of Jammu	42	India
7	University of Notre Dame	42	United States
8	University of Jammu	41	India
9	University of Delhi	40	India
10	University of Manchester	40	United Kingdom

Table 4 presents a snapshot of the global and institutional diversity in the physics research cited by scholars at the CUJ. The table ranks the top 10 institutions based on the frequency of articles cited, showcasing a mix of American, Chinese, Indian and British institutions that dominate the citations. The University of California has 95 citations, followed by other prominent institutions from the United States, such as the University of Tennessee and Michigan State University. Tsinghua University represents China, indicating a strong international presence in the cited research. Notably, Indian institutions, including the Central University of Jammu, the University of Jammu, and the University of Delhi, are among the most cited, showcasing the university’s engagement with national and global research outputs. Argonne National Laboratory and the University of Manchester highlight the diversity and international collaboration within the physics community, emphasising the blend of academic and research centre influences in the field.

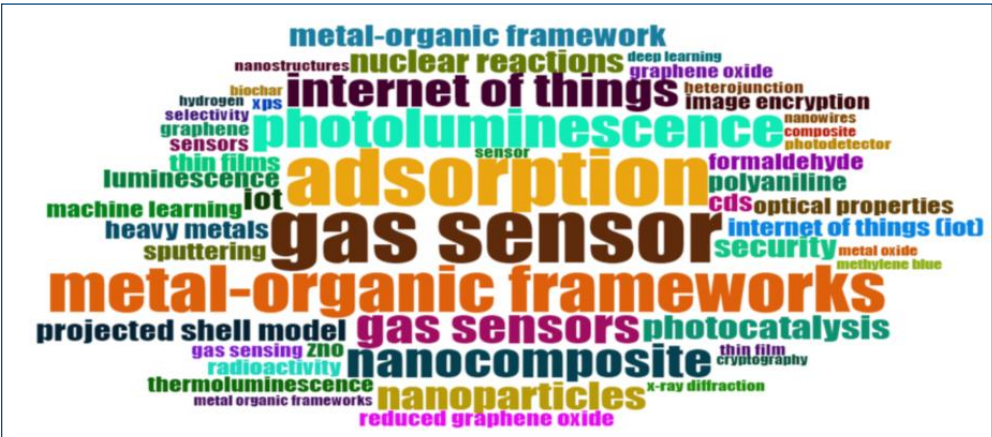


Fig. 2: Word Clouds of Top 50 Keywords in Physics Research

Keywords Analysis

The Word Cloud shown in Fig. 2 visualises the top 50 author keywords that offer valuable insights into the primary research interests and focus areas within the physics community at the CUJ. This analysis shows a wide range of topics, indicating the broad scope of physics, as well as specific research trends and technologies of interest. These keywords cover a diverse range of subjects, including advanced material science, nanotechnology, sensing technologies and the application of emerging digital technologies such as the Internet of Things (IoT), machine learning and deep learning. The emphasis on environ-

mental and health applications, through keywords related to pollution control, water purification, and air quality, demonstrates the institution’s commitment to addressing global challenges. Furthermore, the exploration of optical and electronic properties of materials indicates on-going research in the field of photonics and optoelectronics. The presence of both theoretical concepts and applied research themes shows a rich, multidisciplinary approach to physics, combining fundamental principles with practical innovations. This keyword diversity reflects the dynamic and expansive nature of physics research at the CUJ and suggests a strong potential for impactful interdisciplinary collaborations.

The co-word network analysis (Fig. 3) of author keywords found in the sources cited by the physics researchers at the CUJ in their research publications presents a complex web of interconnected themes and collaborative dynamics. The most significant themes are “gas sensor,” “graphene” and “adsorption,” which connects various research areas and highlight their importance in interdisciplinary studies. The analysis identifies several vital clusters, ranging from sensing technologies and optical properties to integrating physics with digital technologies like IoT and machine

learning. This diversity highlights a broad spectrum of research interests, from material science to emerging tech intersections. Notably, the network signals strong potential for interdisciplinary collaborations, especially between material science and digital technologies, pointing towards innovative future research directions. This co-word analysis not only outlines the current research focus but also predicts evolving trends and opportunities for novel advancements within the physics community at the university.

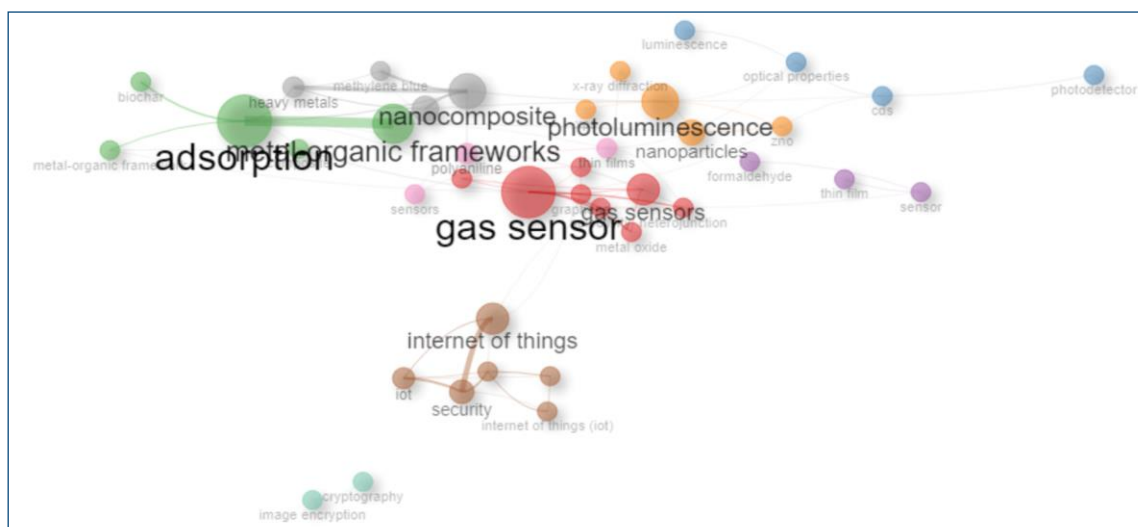


Fig. 3: Co-Word Network Analysis of Author Keywords

Findings and Conclusions

The citation and publication patterns among physics researchers at the CUJ demonstrate a strong preference for journal articles, accounting for over 77% of citations. This finding indicates the importance of peer-reviewed articles in disseminating new scientific knowledge. Conference articles (4.80%) and review articles (7.02%) also play significant roles, highlighting the value of preliminary research findings and comprehensive literature overviews. The diversity in cited journals, with a focus on high-impact Quartile 1 journals, emphasises the quality and international scope of the research. Co-citation network of sources further reveals the centrality of important journals and the interdisciplinary nature of research themes, especially in areas bridging physics with digital technologies and material science. The authorship patterns in the field of physics point towards a collaborative research culture, where most of the

research work is carried out by teams. This reflects the multi-faceted and complex nature of physics research. The institutional collaboration patterns highlight a vast network of partnerships both within India and internationally, which facilitates a rich exchange of ideas and advancements. The keyword analysis shows diverse research interests, ranging from foundational physics to applied technologies and interdisciplinary studies, which indicate a vibrant and evolving research environment. The findings of the study emphasise the engagement of CUJ's physics researchers in high-quality and impactful research, as evidenced by the emphasis on high h-index and top quartile journals. The strong inclination towards citing collaborative research indicates the value placed on diverse expertise and teamwork in advancing scientific knowledge. A significant proportion of citations from international institutions suggest robust global research networks, which are crucial for keeping abreast of cutting-edge developments and integrating diverse perspectives into the university's research output.

Overall, the physics research community at the Central University of Jammu engages in high-quality, collaborative, and interdisciplinary research. Their citation practices demonstrate a focus on peer-reviewed journal articles and engagement with high-impact journals. The university's research ecosystem contributes to cross-disciplinary efforts, leading to breakthroughs extending beyond traditional physics. The community's diverse research interests encompass both theoretical and applied aspects of physics, integrating emerging technologies and positioning the university as a dynamic participant in the global scientific dialogue. The research themes range from material science to applications in digital technology, blurring the traditional boundaries of physics. This interdisciplinary approach reflects a broader trend in scientific research towards addressing complex, real-world problems that require insights from multiple disciplines. In conclusion, the study suggests that the Central University of Jammu's physics research community is well-positioned to enhance the impact and relevance of the university's research, not only in physics but also beyond. Fostering interdisciplinary collaborations and expanding the global research network will be essential to further advancing the domain of physics.

References

- Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4), 959-975. doi:https://doi.org/10.1016/j.joi.2017.08.007
- Bornmann, L., & Daniel, H. (2008). What do citation counts measure? A review of studies on citing behavior. *Journal of Documentation*, 64(1), 45-80. doi:https://doi.org/10.1108/00220410810844150
- Das, A. K., Das, G., & Dutta, B. (2021). A selective review of bibliometric studies on Indian physics and astronomy research output. *Annals of Library and Information Studies*, 68(2), 152-169. Retrieved from <http://nopr.nisep.res.in/handle/123456789/57433>
- Deveci, İ. (2023). Bibliometric analysis of published documents on entrepreneurship in basic sciences (Physics, Chemistry, Biology). *Journal of Turkish Science Education*, 20(1), 211-240. doi:https://doi.org/10.36681/tused.2023.012
- Garfield, E. (1955). Citation indexes for science. *Science*, 122(3159), 108-111. doi:https://doi.org/10.1126/science.122.3159.108
- Jalal, S. K., & Koner, S. (2021). Research collaboration by faculty members in Physics in the University of Calcutta during 2001-2019: Using bibliometrix R. *Library Philosophy and Practice*, 1-12.
- Katz, J. S., & Martin, B. R. (1997). What is research collaboration? *Research Policy*, 26(1), 1-18. doi:https://doi.org/10.1016/S0048-7333(96)00917-1
- Leydesdorff, L., & Zhou, P. (2005). Are the contributions of China and Korea upsetting the world system of science? *Scientometrics*, 63(3), 617-630. doi:https://doi.org/10.1007/s11192-005-0231-1
- Mahemei, L. K., & Bhatt, R. K. (2020). Research publications of Physics at the Indian Institute of Science, Bengaluru: A scientometrics study. *Library Philosophy and Practice*, 1-13.
- Muruli, N., & Harinarayana, N. S. (2024). Citation behaviour of physics and astronomy researchers in the Western Himalayan region. *DESIDOC Journal of Library & Information Technology*, 44(2), 87-93.
- Porter, A. L., & Rafols, I. (2009). Is science becoming more interdisciplinary? Measuring and mapping six research fields over time. *Scientometrics*, 81(3), 719-745. doi:https://doi.org/10.1007/s11192-008-2197-2
- Pritchard, A. (1969). Statistical bibliography or bibliometrics. *Journal of Documentation*, 25, 348.
- Rafols, I., & Meyer, M. (2010). Diversity and network coherence as indicators of interdisciplinarity: Case studies in bionanoscience. *Scientometrics*, 82(2), 263-287. doi:https://doi.org/10.1007/s11192-009-0041-y
- Ratnavelu, K., Buckman, S. J., & Chin, J. H. (2023). The bibliometric impact of Michael Brunger's research in atomic and molecular physics and chemistry. *European Physical Journal D*, 77(11). doi:https://doi.org/10.1140/epjd/s10053-023-00776-5
- Scheidsteger, T., Haunschild, R., Bornmann, L., & Ettl, C. (2021). Bibliometric analysis in the field of quantum technology. *Quantum Reports*, 3(3), Article 3. doi:https://doi.org/10.3390/quantum3030036
- Schlembach, M. C. (2023). Doctoral dissertations in Chemistry and Physics: A longitudinal study. *Science and Technology Libraries*, 42(4), 441-455. doi:https://doi.org/10.1080/0194262X.2023.2208627
- Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. *Science*, 316(5827), 1036-1039. doi:https://doi.org/10.1126/science.1136099