



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr>



DOI: 10.59474/nuclear.2023.65

A Bibliometric Analysis of Cross-Section Calculations

H. Özdoğan¹, G. Sevim², Y. A. Üncü^{3*}

ORCID: 0000-0001-6127-9680, 0000-0002-2157-3209, 0000-0001-7398-9540

¹ Antalya Bilim University, Vocational School of Health Services, Department of Medical Imaging Techniques, 07190, Antalya, TÜRKİYE

² Antalya Bilim University, Vocational School of Health Services, Department of Opticianry, 07190, Antalya, TÜRKİYE

³ Akdeniz University, Vocational School of Technical Sciences, Department of Biomedical Equipment Technology, 07070, Antalya, TÜRKİYE

Received 26.07.2025; received in revised form 20.08.2025; accepted 25.08.2025

ABSTRACT

In this study, the literature for cross section calculations examined from 2019 to 2023 using the ISI Web of Science (WOS) database to understand the dynamics of scientific communication. The main objective was to perform a bibliometric analysis and model networks among authors, texts, sources, citations, keywords, organizations, and countries. Using the R tool "Bibliometrix" and descriptive statistical techniques, the significant publication trends in co-authorship, citation patterns, institutional collaborations, and the geographic distribution of authorship have been identified. The present findings highlight the importance of international collaboration and interdisciplinary research. The presented bibliometric analysis for cross section calculations has uncovered significant publication trends, particularly regarding co-authorships, citation patterns, institutional collaborations, and the geographic origins of authors.

Keywords: Bibliometric mapping; Citation analysis; Cross section; R programming

1. Introduction

In the field of nuclear physics, both theoretical and experimental studies have played a pivotal role in the development of 20th-century physics. Experimental results from nuclear physics laboratories have contributed significantly to solving numerous intriguing problems. Quantitatively determining the probability of a nuclear reaction occurring has been elucidated through the concept of the cross-section. This quantitative parameter provides insights into the interaction between a projectile and a target, apart from the subsequent products. Therefore, it serves as a crucial source of information in various applications and fields involving nuclear processes.

The inherent complexity of problems in nuclear physics renders analytical solutions virtually impossible. Advances in science and technology have increased the intricacy of the issues. Progress in technology and computer systems has enabled the establishment of

virtual nuclear physics laboratories and the execution of desired experiments and calculations in a computerized environment. Experimental results of nuclear reaction studies are vital for understanding fundamental nuclear physics. Since the energy dependence of nuclear reactions is not always well-known in great detail, it is necessary to investigate cross sections and spectral emission shapes for a wide variety of energies. Transient nuclei typically produced in reactors often have short half-lives, making direct measurement of cross sections and spectral emissions difficult. Therefore, theoretical calculations play an essential complementary role by providing estimates that support experiments and help overcome practical limitations.

Over time, researchers have developed various computer codes incorporating diverse approaches and nuclear models to support theoretical studies and data analysis. These include: GEANT, a simulation toolkit for the

*Corresponding author.

E-mail address: yuncu@akdeniz.edu.tr, (Y.A. Üncü)

Journal of Nuclear Sciences, Vol. 9, No. 2, December 2022, 32-42

Copyright ©, Ankara University, Institute of Nuclear Sciences

ISSN: 2148-7736

passage of particles through matter [1]; LAHET, used for high-energy nuclear reactions [2]; FLUKA, a fully integrated particle physics Monte Carlo simulation package [3]; ALICE91, a precompound model code for nuclear reaction calculations [4]; ALICE-IPPE, a modified version of ALICE91 for improved pre-equilibrium emissions [5]; GNASH, which combines direct, pre-equilibrium, and compound processes [6]; EMPIRE, a modular system for nuclear reaction modeling [7]; TALYS, widely used for nuclear reaction calculations and cross-section evaluations [8]; PCROSS, a code for calculating nuclear reaction cross sections [9]; and CEM95, based on the cascade-exciton model for intermediate-energy reactions [10]. Researchers commonly utilize codes such as TALYS, ALICE/ASH, and EMPIRE, particularly in cross section studies, for two fundamental purposes: examining reactions without experimental data and validating theoretical models. TALYS and EMPIRE programs are the most widely used codes in contemporary research for these purposes [11-18].

Bibliometric studies have become indispensable for mapping scientific activity, identifying knowledge gaps, and guiding future research priorities. In the field of nuclear science and engineering, several recent studies have applied bibliometric techniques to understand global trends. For example, one study investigated publication patterns related to radiation shielding, demonstrating the potential of bibliometric analysis in specific nuclear application areas [19]. A decade-long analysis revealed trends in publication output, key institutions, and international collaboration networks within nuclear energy research [20]. Another study focused on nuclear energy policy in the post-Fukushima era, emphasizing emerging themes such as risk perception, energy transition, and sustainability [21]. Additionally, global output in nuclear science and technology journals has been assessed with attention to productivity, national impact, and authorship patterns [22].

Despite these contributions, there is a noticeable lack of bibliometric research dedicated to nuclear reaction modeling and the computational codes such as TALYS, EMPIRE, and ALICE that are central to theoretical cross section calculations. To address this gap, the present study offers a comprehensive bibliometric analysis of publications related to nuclear reaction modeling, with a particular focus on studies utilizing these computational codes. This work aims to provide meaningful insights into the evolution, emerging trends, and collaborative dynamics within this specialized yet critical area of nuclear research.

2. Materials and Methods

Bibliometric analysis typically involves four key components: data collection, data processing and analysis of academic publications, interpretation of

results, and application of findings. In the data collection phase, relevant documents such as journal articles, proceedings, and other scientific sources are gathered from trusted bibliographic databases or institutional repositories. The data processing and analysis phase includes organizing this information and applying bibliometric indicators such as citation metrics, co-authorship patterns, and keyword frequency to identify trends and patterns. During the interpretation of results, these patterns are visualized using tables, graphs, and network maps to provide meaningful insights. Lastly, in the application of results phase, the outcomes of bibliometric analysis are used by researchers, institutions, funding bodies, and policymakers to inform strategic decisions, allocate resources, and guide future research directions [23–27].

The bibliometric data for this study were retrieved from the Science Citation Index (SCI), a component of the Web of Science (WoS) core collection. This database functions both as a bibliographic and citation index, offering standardized information on publications, authors, institutions, and countries. The structured indexing within WoS allows for consistent and accurate retrieval of scientific output. WoS also provides built-in tools for generating citation-based indicators and supports advanced bibliometric techniques such as co-citation, bibliographic coupling, co-word analysis, and collaborative network mapping. For data analysis and visualization, the open-source R programming package Bibliometrix was used. This tool enables automated processing of WoS data and the generation of descriptive statistics, science maps, and network visualizations essential for bibliometric interpretation [28, 29].

In this study, bibliometric data were collected using the search term "Reaction Cross-section Calculation" within the Web of Science (WoS) database, covering the period from 2019 to 2023. The dataset was manually exported from WoS and analyzed using the open-source R package Bibliometrix, which provides automated tools for processing bibliographic data and generating visualizations. The use of Bibliometrix allowed for the efficient exploration of citation patterns, keyword distributions, author networks, and thematic evolution across the selected documents.

Defining and selecting the appropriate document set is a critical step in bibliometric mapping, as it directly affects the reliability of citation and network analyses. In this study, document inclusion was based on semantic similarity using a combination of title keywords, author-defined keywords, and Keyword Plus terms provided by WoS. These terms were selected to ensure alignment with the core concept of reaction cross-section calculations. To enhance coverage, linguistic similarities in titles, abstracts, and keywords were also considered. By integrating these elements, the document set more accurately reflects the thematic scope of the research field.

To ensure comprehensive coverage of the field, additional refinement of the dataset was based on linguistic similarities found in article titles, abstracts, and keyword fields. Most publications indexed in Scopus and Web of Science provide structured metadata that includes these components, facilitating semantic filtering and thematic alignment. Relevant articles were downloaded directly from the WoS database and processed in supported formats such as CSV or BibTeX. The extracted records were imported into a bibliographic database for further analysis. Full-text formats (PDF, XML, or HTML) were used when necessary to confirm content relevance. All bibliometric data analyzed in this study were derived from documents specifically focused on reaction cross-section calculations, selected according to predefined inclusion criteria based on bibliometric methodology.

The dataset used in this study was extracted from the Web of Science (WoS) database under the following criteria: articles containing the keyword “reaction cross-section calculation”, published or accepted for publication between January 2019 and September 2023, and categorized as either “article” or “early access article.” After applying these filters, a total of 1,769 documents from 271 different sources were identified. Among these, 23 articles were classified as early access. Additionally, 108 of the publications were single-authored, produced by 87 distinct authors. A detailed summary of the dataset is presented in Table 1.

The bibliometric analysis was conducted using the R programming language in conjunction with the RStudio development environment. The analysis utilized ready-made packages and functions provided by the Bibliometrix library, which is specifically designed for comprehensive science mapping and bibliometric evaluation. These tools enabled structured assessment of citation metrics, keyword co-occurrence, authorship networks, and source impact. Custom functions were also implemented where necessary to tailor the analysis to the specific scope of the study [27, 29].

3. Results and Discussion

The visualization of bibliometric data in this study provided insights into the structure and evolution of the research field on reaction cross-section calculations. Citation patterns, country-level contributions, and collaboration networks were explored through data visualization techniques. Prior research has shown the effectiveness of visualization in academic trend analysis and institutional assessment [30–32]. In line with these approaches, the current study identified key clusters of authors and institutions that dominate publication output in the field. Besides, author productivity displayed a pattern consistent with Lotka’s Law, which suggests that

a small number of researchers contribute the majority of scientific output [33]. These visual patterns help reveal the concentration of expertise, international partnerships, and emerging areas of interest in the domain.

Table 1. Main Information about Web of Science (WOS) Data

Description	Results
Timespan	2019-2023
Sources (Journals, Books, etc.)	271
Documents	1769
Annual Growth Rate %	-11.29
Document Average Age	2.18
Average citations per doc	4.42
References	53851
DOCUMENT CONTENTS	
Keywords Plus (ID)	3438
Author's Keywords (DE)	3048
AUTHORS	
Authors	7609
Authors of single-authored docs	87
AUTHORS COLLABORATION	
Single-authored docs	108
Co-Authors per Doc	8.75
International co-authorships %	39.63
DOCUMENT TYPES	
Article	1717
Article; data paper	2
Article; early access	23
Article; proceedings paper	27

3.1. Analysis of Annual Production and Average Citations

Fig. 1 represents the annual number of scientific publications produced between 2019 and 2023. The number of publications related to nuclear cross-section studies started to decrease after 2021, although it didn't remarkably change between 2019 and 2021, as seen in Fig. 1. This change has begun by decreasing from

approximately 400 publications in 2021 to approximately 350 publications in 2022. This decline continued sharply with the number of publications remaining below 250 between 2022 and 2023.

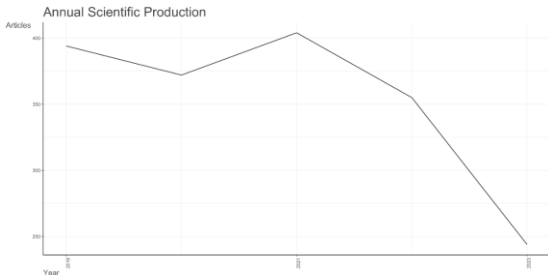


Fig. 1 The annual number of scientific publications produced between 2019 and 2023

When examining the average citations of these publications per year (Fig.2) , it is seen that the average citations between 2021 and 2023 support the decrease in the number of nuclear cross-section publications between 2021 and 2023. Although there was a decrease in the annual average citations between 2019 and 2021, one determined a drastic decrease after 2021, similar to the analysis of the number of studies.

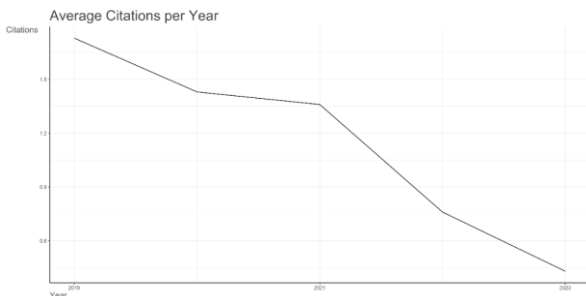


Fig.2 The annual average citations of publications produced between 2019 and 2023

3.2. Analysis of Authors and Their Countries, Affiliations and Collaborations

Fig. 3 shows the authors who have contributed the most to the field of nuclear cross-section by actively producing publications in the last five years. Generally, there is not much difference in the number of publications between the first eight authors. However, the author who published the most in this field (with 28 publications) is Ogata, K. The other authors

who contributed the most to the field (with 24 publications each) are Özdoğan, H. And Şekerci, M. The third author who contributed the most to the field (with 23 publications) is Kaplan, A.

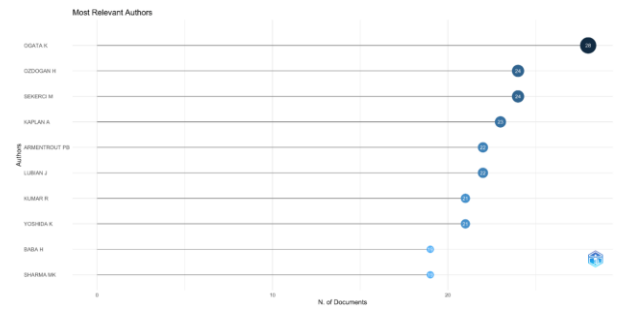


Fig. 3 The number of scientific publications produced in terms of author between 2019 and 2023

However, when examining Fig.4, which shows the productivity of authors over time, Ogata K. stood out with both the number of articles and citations in 2019, while there was a decrease in the number of his articles in 2023. Fig. 4 shows Kumar R. as the most productive author in 2023. When examining the productivities of Özdoğan H., Şekerci M, and Kaplan A., the second and third most productive authors in this field between 2019 and 2023, they have maintained their publication stability in terms of productivity without any explicit changes.

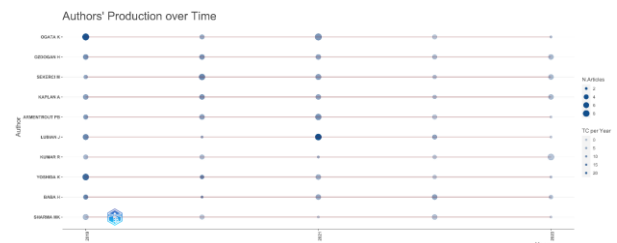


Fig. 4 Top authors' production over the time (between 2019-2023)

Lotka's law, one of the bibliometric analysis methods, logarithmically describes the relationship between the number of authors and the number of authors' contributions [33]. In this context, when examining Fig. 5, one can see the number of each author's contributions ranging from one to approximately twenty-eight papers. However, in this process, it is noticeable that more than 60% of the authors produced only one manuscript in this field, while only a small proportion contributed a noteworthy number of articles for this research area.

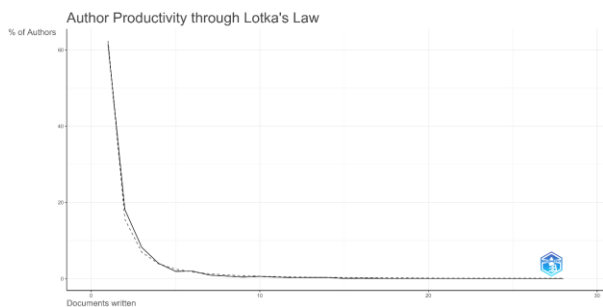


Fig. 5 Author productivity through Lotka's Law

Fig.6 shows the corresponding countries for reaction cross-section calculations between 2019 and 2023. China produced the highest number of publications, with approximately 80% of them being single-country publications, making it the leading contributor in this category. The United States, ranked second in total output, had the largest share of multiple-country publications, highlighting its strong international collaboration. In contrast, the vast majority of Turkey's publications were single-country studies, which makes Turkey's contribution particularly noteworthy in this context.

In brief, the results indicate that researchers in the USA tend to conduct collaborative studies in the reaction cross-section calculations field more frequently than researchers in other countries. Fig.7 presents the "Country Collaboration Map," which visualizes international research partnerships in this area. The map shows that China produced the highest number of publications, with about 80% being single-country publications, reflecting limited international collaboration despite high output. In contrast, the United States ranked second in total publications, with nearly 45% of its output being multiple-country publications, highlighting its strong emphasis on international collaboration. For Türkiye, more than 85% of the publications were single-country studies, indicating limited participation in international networks compared to leading contributors.

The collaboration map further reveals that the strongest partnerships exist between North America and Europe, particularly among the USA, Germany, and the UK, forming a dense transatlantic collaboration network. Strong intra-European collaborations are also evident, alongside notable links with East Asia, particularly China and Japan. Australia also participates in collaborative efforts, though to a lesser extent, while South America, Africa, and parts of Asia show relatively sparse collaboration links. These findings highlight the central role of North America and Europe in fostering international cooperation and point to the need for greater global participation, especially from regions where collaborative research remains limited.



Fig. 6 The corresponding Author's Country between 2019-2023



Fig.7 The graph of the country collaboration map of the reaction cross section calculations' field between 2019-2023

Fig.8 presents the distribution of citations among countries in the field of reaction cross-section calculations between 2019 and 2023. The United States registered the highest citation count (1,450), followed closely by China (1,400), with Germany occupying the third position. These results indicate that countries characterized by stronger collaborative research networks, as illustrated in Figs. 6 and 7, tend to achieve greater citation impact. It is important to note that the citation counts reported here encompass all citations indexed in WoS, including self-citations. While this approach ensures methodological consistency across countries, it may result in a modest inflation of citation counts for nations with particularly high publication volumes.

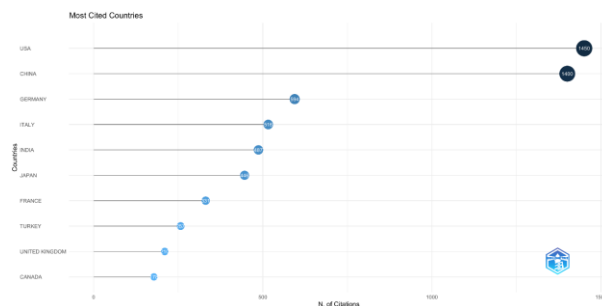


Fig. 8 The most cited countries in the reaction cross section calculations between 2019-2023

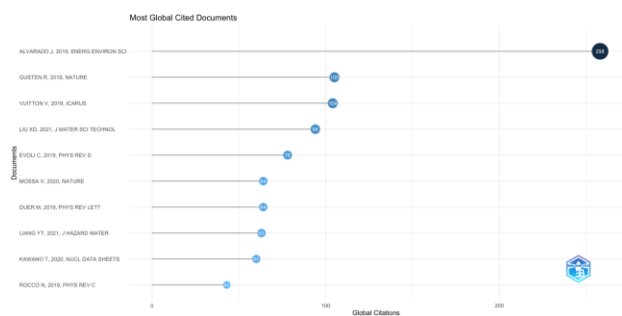


Fig. 9 The most global cited documents in the reaction cross section calculations between 2019-2023

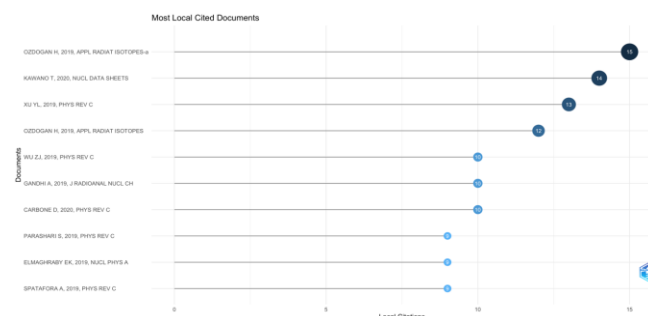


Fig. 10 The most local cited documents in the reaction cross section calculations between 2019-2023

Table 2. The top 10 documents with the highest global and local citations

Documents	Global Citation		Document	Local Citation		
	TC	Doi		LC	GC	Doi
[34]	258	10.1039/c8ee02601g	[14]	15	20	10.1016/j.apradiso.2018.10.011
[35]	105	10.1038/s41586-019-1090-x	[37]	14	60	10.1016/j.nds.2019.12.002
[36]	104	10.1016/j.icarus.2018.06.013	[39]	13	18	10.1103/PhysRevC.99.034618
[40]	94	10.1016/j.jmst.2020.09.012	[41]	12	13	10.1016/j.apradiso.2018.10.007
[42]	78	10.1103/PhysRevD.99.103023	[43]	10	41	10.1103/PhysRevC.100.014612
[44]	64	10.1038/s41586-020-2878-4	[15]	10	15	10.1007/s10967-019-06533-6
[45]	64	10.1103/PhysRevLett.122.172502	[46]	10	28	10.1103/PhysRevC.102.044606
[47]	63	10.1016/j.jhazmat.2021.126584	[48]	9	19	10.1103/PhysRevC.99.044602
[37]	60	10.1016/j.nds.2019.12.002	[49]	9	11	10.1016/j.nuclphysa.2019.01.009
[50]	43	10.1103/PhysRevC.99.025502	[51]	9	23	10.1103/PhysRevC.100.034620

TC: Total Citation, LC: Local Citation, GC: Global Citation

The most globally cited documents and the most locally cited documents are presented in Figs. 9 and 10, respectively. As illustrated in Fig. 9, the article by Alvarado et al. in Energy & Environmental Science received the highest number of global citations (258), reflecting a strong international impact [34]. This is followed by the study authored by Güsten and published in Nature [35], and the work of Vuitton et al. in Icarus [36], with 105 and 104 citations, respectively. These results highlight the influence of a small number of highly cited publications in shaping research directions within the field.

The most local cited documents, which might refer to citations within a specific region, country, or community, were given in Fig. 10. The document written by Özdoğan et al. and published in Applied Radiation and Isotopes [14] has the highest local citation count at 15, indicating its prominence within the local or specialized scholarly community. Close behind are documents, written by Kawano et al. and published in Nuclear Data Sheets [37], and written by Xu et al. and published in Physical Review C [38] with 14 and 13 local citations, respectively, which suggests these documents are also significant in local or specialized discussions and research.

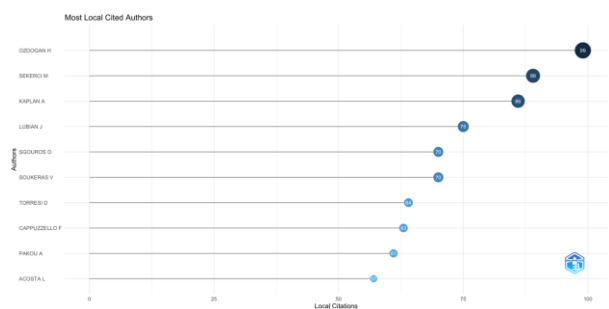


Fig. 11 The most local cited authors in the reaction cross section calculations between 2019-2023

Fig. 11 illustrates the authors with the highest number of local citations in the field of reaction cross-section calculations. Özdoğan H. (99), Şekerci M. (89), and Kaplan A. (86) record the highest citation counts, highlighting their substantial influence within the research community. Lubian J. (76), Souliotis G. (70), and Soukeras V. (70) also demonstrate notable visibility, while Torresi D. (64), Cappuzzello F. (63), Pakou A. (61), and Acosta L. (57) show relatively lower but still meaningful levels of local influence. Overall, the distribution indicates that scholarly impact in this field is concentrated among a relatively small group of researchers.

Global citation performance has already been presented at the document level in Figs. 9 and 10. Local citation data is displayed in Fig.11 because it provides a more accurate representation of researchers' influence within the specific discipline.

3.3. Analysis of Journals

When examining the journal that published the manuscripts in Fig. 12, data shows that Physical Review C is the top journal with the highest number of articles published in this field, with 365 articles between 2019 and 2023. The second most published journal in this field is European Physical Journal A with 67 articles. It is seen that third place is shared by Applied Radiation and Isotopes and Journal of Physical Chemistry A with 60 publications. Bradford's Law is used to analyze the productivity of journals in more detail and to determine the core journals in this field (Fig. 13).

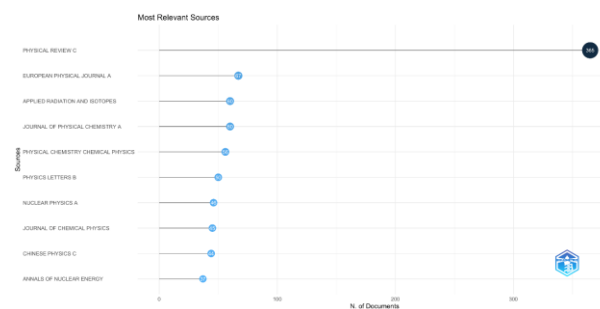


Fig. 12 Most relevant sources to nuclear reaction cross section between 2019-2023

Accordingly, journals were ranked according to the number of articles they published over the examined period. As shown in Fig.13, this distribution follows Bradford's Law, which is commonly used to analyze journal productivity in detail and to identify core journals within a research field. In this context, Physical Review C emerges as the leading journal for nuclear reaction cross-section studies, followed by European Physical Journal A, Applied Radiation and Isotopes, Journal of Physical Chemistry A, and Physical Chemistry Chemical Physics. These journals collectively represent the core publication outlets in this domain.

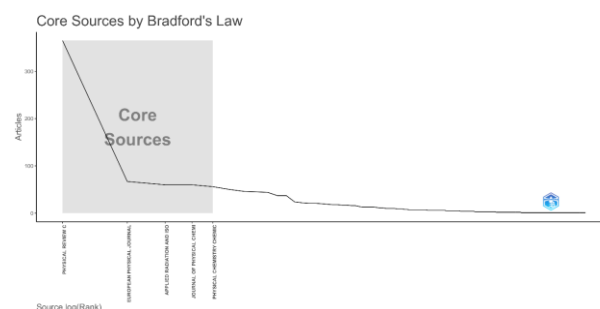


Fig. 13 Core journal by Bradford's Law between 2019-2023

3.4. Analysis of Co-Words

Trend topics can be used to identify the subjects most frequently addressed in publications over specific time periods and to reveal emerging research directions in the field. Keywords provided in the publications form the basis for determining these trends.

As shown in Fig. 14, the trend topics of manuscripts published in 2019 were primarily associated with “transition state,” “coefficients,” and “forces.” In contrast, terms such as “cross-section calculations” and “nat” (natural isotopes or natural targets) appeared predominantly between 2022 and 2023.

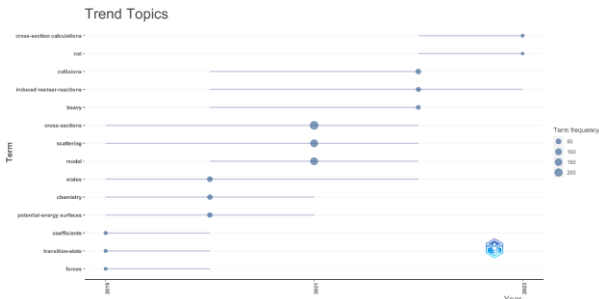


Fig. 14 Trend topics in nuclear reaction cross section between 2019-2023

Using common word networks, one can analyze the relationship between keywords used in publications and their usage in the field. In this context, common words associated with publications also provide information about the topics in the publications. The most commonly used terms for the nuclear reaction cross-section area are visualized as a word map tree in Fig. 15. The first five words that stand out in this field are cross-sections, scattering, model, excitation functions, and nuclei.



Fig. 15 Word tree map for field of nuclear reaction cross section between 2019-2023

In addition to co-word analysis, as shown in Fig. 16, a thematic relationship–development map can be constructed to reveal the conceptual structure and evolution of the research field from a broader perspective. This approach allows for clearer inferences regarding the developmental trajectory of the domain. The thematic map in Fig. 16 consists of four fundamental categories: basic themes, emerging and declining

themes, niche themes, and motor (driving) themes. Niche themes represent very specialized areas; for instance, the words state, chemistry, and potential-energy surfaces are located in this region. In contrast, terms such as cross-section, scattering, and dynamics are positioned within the basic themes category, reflecting their central role in the field. Words such as excitation-function, library, and nuclear-data sheets appear in the intersection of niche and motor themes, indicating their importance both as specialized research directions and as driving forces for broader developments.

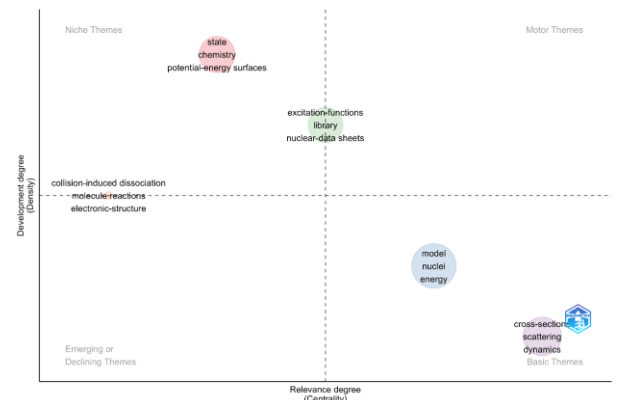


Fig. 16 Thematic map for nuclear reaction cross section

4. Conclusions

This study employed bibliometric techniques, supported by R-based analysis, to provide a comprehensive overview of research on nuclear reaction cross-section calculations. By combining quantitative indicators with network analysis, the study offers insights into the structural and collaborative dynamics of the field.

The results highlight several key findings. First, a limited number of authors, including Özdoğan H., Şekerci M., and Kaplan A., have emerged as the most influential contributors, with consistently high citation counts and strong visibility within the research community. At the country level, China has produced the largest volume of publications, while the United States has distinguished itself through a high proportion of international collaborations, which also correlate with higher citation impact. Turkey, although productive, remains dominated by single-country publications, reflecting a need for stronger integration into international networks.

Collaboration and citation mapping further reveal the intellectual and social dimensions of the field. Intellectual networks refer to the co-citation and thematic linkages between publications, indicating the shared conceptual foundations of the discipline, while social networks capture co-authorship patterns that reflect collaborative practices among researchers, institutions,

and countries. Together, these networks demonstrate that cross-section research is both thematically consolidated around core concepts (such as cross-section and scattering) and increasingly driven by emerging areas (such as excitation functions and nuclear data libraries).

In summary, the bibliometric evidence suggests that the field is shaped by a small number of highly influential authors, strong collaborative clusters across the USA, Europe, and East Asia, and an ongoing thematic shift from traditional scattering studies toward data-intensive and application-oriented directions. These findings provide a structured perspective on the evolution of cross-section research and highlight the importance of international collaboration and thematic diversification in sustaining its future growth.

Acknowledgment

Authors contributed equally to this work. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

[1] S. Agostinelli et al., “GEANT4—a simulation toolkit,” *Nucl. Instrum. Methods Phys. Res. A*, vol. 506, no. 3, pp. 250–303(2003).

[2] R. E. Prael and H. Lichtenstein, *User Guide to the LAHET Code System*, Los Alamos National Laboratory Report LA-UR-89-3014 (1989).

[3] T. T. Böhlen et al., “The FLUKA Code: Developments and Challenges for High Energy and Medical Applications,” *Nucl. Data Sheets*, vol. 120, pp. 211–214 (2014).

[4] M. Blann, *ALICE91: Precompound Model Code for Nuclear Reaction Calculations*, Report (1991).

[5] A. I. Dityuk, A. Y. Konobeyev, V. P. Lunev, and Y. N. Shubin, *ALICE-IPPE – An Updated Version of ALICE91 for Precompound Nuclear Reactions*, Obninsk: Institute of Physics and Power Engineering, (1998).

[6] P. G. Young and E. D. Arthur, *Comprehensive Nuclear Model Code System – GNASH*, Los Alamos National Laboratory Report LA-UR-89-3014 (1989).

[7] M. Herman et al., “EMPIRE: Nuclear Reaction Model Code System for Data Evaluation,” *Nucl. Data Sheets*, vol. 108, no. 12, pp. 2655–2715 (2007).

[8] A. J. Koning, S. Hilaire, and M. C. Duijvestijn, “TALYS-1.0,” in *Proceedings of the International Conference on Nuclear Data for Science and Technology*, Nice, France, pp. 211–214 (2007).

[9] T. Kawano, T. Ohsawa, K. Shibata, and H. Nakashima, “Nuclear Data Calculations Using JENDL High Energy File,” *J. Nucl. Sci. Technol.*, vol. 41, no. Suppl. 2, pp. 1221–1225 (2004).

[10] S. G. Mashnik, A. J. Sierk, and R. E. Prael, *Cascade-Exciton Model of Nuclear Reactions: CEM95 Code Manual*, Los Alamos National Laboratory Report LA-UR-98-6000 (1995).

[11] A. Kaplan, H. Özdoğan, A. Aydın, and E. Tel, “ $(\gamma, 2n)$ Reaction Cross Section Calculations on Several Structural Fusion Materials,” *Journal of Fusion Energy*, vol. 32, no. 4, pp. 431–436 (2013).

[12] A. Kaplan, İ. H. Sarpün, A. Aydın, E. Tel, V. Çapalı, and H. Özdoğan, “ $(\gamma, 2n)$ -Reaction cross-section calculations of several even-even lanthanide nuclei using different level density models,” *Physics of Atomic Nuclei*, vol. 78, no. 1, pp. 53–64 (2015).

[13] H. Özdoğan, M. Şekerci, and A. Kaplan, “A new developed semi-empirical formula for the (α, p) reaction cross-section at 19 ± 1 MeV,” *Mod Phys Lett A*, vol. 34, no. 06, p. 1950044 (2019).

[14] H. Özdoğan, M. Şekerci, and A. Kaplan, “Investigation of gamma strength functions and level density models effects on photon induced reaction cross-section calculations for the fusion structural materials $46,50\text{Ti}$, 51V , 58Ni and 63Cu ,” *Applied Radiation and Isotopes*, vol. 143, pp. 6–10 (2019).

- [15] A. Gandhi et al., “Cross section calculation of (n,p) and (n,2n) nuclear reactions on Zn, Mo and Pb isotopes with ~14 MeV neutrons,” *J Radioanal Nucl Chem*, vol. 322, no. 1, pp. 89–97 (2019).
- [16] H. Azizakram, M. Sadeghi, P. Ashtari, and F. Zolfagharpour, “An overview of ¹²⁴I production at a medical cyclotron by ALICE/ASH, EMPIRE-3.2.2 and TALYS-1.6 codes,” *Applied Radiation and Isotopes*, vol. 112, pp. 147–155 (2016).
- [17] A. B. Olorunsola, J. A. Bamikole, A. A. Bello, O. M. Ikumapayi, and B. A. Adaramola, “Model calculation and evaluation of neutron induced reaction cross-section on ²³⁷Np, ²⁴¹Am and ²⁴⁵Cm using EMPIRE 3.2 code,” *AIP Conf Proc*, vol. 2754, no. 1, p. 030010 (2023).
- [18] L. Yettou and M. Belgaid, “Calculation of pre-equilibrium effects in neutron-induced cross section on ^{32,34}S isotopes using the EMPIRE 3.2 code,” *EPJ Web Conf*, vol. 100, p. 01009 (2015).
- [19] O. Kilicoglu and H. Mehmetcik, “Science mapping for radiation shielding research,” *Radiation Physics and Chemistry*, vol. 189, p. 109721 (2021).
- [20] L. Obregón, C. Orozco, J. M. Camargo, J. Duarte, and G. Valencia, “Research trend on nuclear energy from 2008 to 2018: A bibliometric analysis,” *International Journal of Energy Economics and Policy*, vol. 9, no. 4, pp. 106–115 (2019).
- [21] S. Permana, “Two decades of nuclear energy policy and its impact on Indonesia: A bibliometric review,” *International Journal of Energy Economics and Policy*, vol. 12, no. 1, pp. 1–6 (2022).
- [22] A. Mardani and S. Abdiazar, “Global research status in leading nuclear science and technology journals during 2001–2010,” *Library Review*, vol. 63, no. 4/5, pp. 324–339 (2014).
- [23] A. Andrés, *Measuring academic research: How to undertake a bibliometric study*. Elsevier (2009).
- [24] S. M. Lawani, “Bibliometrics: Its Theoretical Foundations, Methods and Applications,” vol. 31, no. Jahresband, pp. 294–315 (1981).
- [25] B. Martin, “What can bibliometrics tell us about changes in the mode of knowledge production?,” *Prometheus*, vol. 29, pp. 455–479, Dec. (2011).
- [26] M. Mering, “In Lay Terms: Bibliometrics: Understanding Author-, Article- and Journal- Level Metrics,” *Serials Review*, vol. 43, p. 0, Jan. (2017).
- [27] M. Aria and C. Cuccurullo, “bibliometrix: An R-tool for comprehensive science mapping analysis,” *J Informetr*, vol. 11, no. 4, pp. 959–975 (2017).
- [28] C. Neuhaus and H.-D. Daniel, “Data Sources for Performing Citation Analysis: An Overview,” *Journal of Documentation*, vol. 64, pp. 193–210, Mar. (2008).
- [29] M. McLean, “RefManageR: Import and Manage BibTeX and BibLaTeX References in R,” *The Journal of Open Source Software*, vol. 2, Aug. (2017).
- [30] M. S. Zakaria, “Data visualization as a research support service in academic libraries: An investigation of world-class universities,” *The Journal of Academic Librarianship*, vol. 47, no. 5, p. 102397 (2021).
- [31] K. Healy and J. Moody, “Data Visualization in Sociology,” *Annu Rev Sociol*, vol. 40, pp. 105–128, Jul. (2014).
- [32] C. Perin, R. Vuillemot, C. D. Stolper, J. T. Stasko, J. Wood, and S. Carpendale, “State of the Art of Sports Data Visualization,” *Computer Graphics Forum*, vol. 37, no. 3, pp. 663–686, Jun. (2018).
- [33] A. J. Lotka, “The frequency distribution of scientific productivity,” *J. Wash. Acad. Sci.*, vol. 16, no. 12, pp. 317–325 (1926).
- [34] J. Alvarado et al., “Bisalt ether electrolytes: a pathway towards lithium metal batteries with Ni-rich cathodes,” *Energy Environ Sci*, vol. 12, no. 2, pp. 780–794 (2019).

- [35] R. Güsten et al., “Astrophysical detection of the helium hydride ion HeH+,” *Nature*, vol. 568, no. 7752, pp. 357–359 (2019).
- [36] V. Vuitton, R. V Yelle, S. J. Klippenstein, S. M. Hörst, and P. Lavvas, “Simulating the density of organic species in the atmosphere of Titan with a coupled ion-neutral photochemical model,” *Icarus*, vol. 324, pp. 120–197 (2019).
- [37] T. Kawano et al., “IAEA Photonuclear Data Library 2019,” *Nuclear Data Sheets*, vol. 163, pp. 109–162 (2020).
- [38] Y. Xu, Y. Han, H. Liang, Z. Wu, H. Guo, and C. Cai, “Global optical model potential for the weakly bound projectile ^9Be ,” *Phys Rev C*, vol. 99, no. 3, p. 34618, Mar. (2019).
- [39] Y. Xu, Y. Han, H. Liang, Z. Wu, H. Guo, and C. Cai, “Global optical model potential for the weakly bound projectile $\text{Be } 9$,” *Phys Rev C*, vol. 99, no. 3, p. 034618 (2019).
- [40] X. Liu, Y. Huang, L. Ding, X. Zhao, P. Liu, and T. Li, “Synthesis of covalently bonded reduced graphene oxide- Fe_3O_4 nanocomposites for efficient electromagnetic wave absorption,” *J Mater Sci Technol*, vol. 72, pp. 93–103, May (2021).
- [41] H. Özdoğan, “Theoretical calculations of production cross-sections for the ^{201}Pb , ^{111}In ^{18}F and ^{11}C radioisotopes at proton induced reactions,” *Applied Radiation and Isotopes*, vol. 143, pp. 1–5 (2019).
- [42] C. Evoli, R. Aloisio, and P. Blasi, “Galactic cosmic rays after the AMS-02 observations,” *Physical Review D*, vol. 99, no. 10, p. 103023, May (2019).
- [43] Z. Wu and L. Guo, “Microscopic studies of production cross sections in multinucleon transfer reaction $^{58}\text{Ni } ^{124}\text{Sn}$,” *Phys Rev C*, vol. 100, no. 1, p. 14612, Jul. (2019).
- [44] V. Mossa et al., “The baryon density of the Universe from an improved rate of deuterium burning,” *Nature*, vol. 587, no. 7833, pp. 210–213, (2020).
- [45] M. Duer et al., “Direct observation of proton-neutron short-range correlation dominance in heavy nuclei,” *Phys Rev Lett*, vol. 122, no. 17, p. 172502 (2019).
- [46] D. Carbone et al., “Analysis of two-nucleon transfer reactions in the $\text{Ne } 20+ \text{ Cd } 116$ system at 306 MeV,” *Phys Rev C*, vol. 102, no. 4, p. 044606 (2020).
- [47] Y. Liang et al., “Benzene decomposition by non-thermal plasma: A detailed mechanism study by synchrotron radiation photoionization mass spectrometry and theoretical calculations,” *J Hazard Mater*, vol. 420, p. 126584 (2021).
- [48] S. Parashari et al., “Systematic analysis of the neutron-induced reaction cross sections for nat Mo isotopes within 10–20 MeV,” *Phys Rev C*, vol. 99, no. 4, p. 44602, Apr. (2019).
- [49] E. K. Elmaghraby, G. Y. Mohamed, and M. Alabyad, “Experimental investigation and nuclear model calculations for proton induced reactions on indium around thresholds,” *Nucl Phys A*, vol. 984, pp. 112–132 (2019).
- [50] N. Rocco, C. Barbieri, O. Benhar, A. De Pace, and A. Lovato, “Neutrino-nucleus cross section within the extended factorization scheme,” *Phys Rev C*, vol. 99, no. 2, p. 25502, Feb. (2019).
- [51] A. Spatafora et al., “ $\text{Ne } 20+ \text{ Ge } 76$ elastic and inelastic scattering at 306 MeV,” *Phys Rev C*, vol. 100, no. 3, p. 034620 (2019).