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Research Productivity of Nuclear Science in India: A Scientometric Study

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Abstract

The present study is based on the Indian output of 10,278 research papers in nuclear science as indexed in Web of Science database for the period of 10 years (2009 to 2018), with a view to understand India's growth, geographical distribution of the publications, research communication in core journals, institutional productivity, highly productive scientists. It is noted from the study that India has produced highest number of papers i.e. 1189, 11.57% scholarly publications 4530 citations with 3.81 average citations per papers in the year 2016, highest research output is from Radiology Nuclear Medicine Medical Imaging 5589 with 32.52% share, leading journal is Journal of Radio analytical and Nuclear Chemistry with 900 publications 18.60% share, followed by most prolific research institutions of India is Bhabha Atomic Research Centre, Mumbai that has contributed the highest i.e. 2151, 38.62% publications, highly productive scientist is Kumar A. 568 publications with 21.05 % share, Further, International collaborative share 612 articles of India in this research output was with United States with 28.32% share. Besides articles appeared in the journals have shown a predominant contribution 7670 publications with 69.48% share. It is also observed that 10275 articles with 99.97% share in English.

Keywords: Scientometric; Nuclear Science research; Publication output; Scientometric analysis; Growth and collaboration.

Introduction

Scientometrics is a discipline which analyses scientific publications and citations appended to the papers to gain an understanding of the structure of science, growth of science at global level, performance of a country in a particular domain, performance of institutions, departments, and scientific eminence of an individual scientist. (Kademani, 2008).[1] Scientometric study, its guide to the librarians in knowing the information seeking behavior of researchers where they publish and what they cite. Nuclear Science is the field of physics that studies atomic nuclei and their constituents and interactions. Other forms of nuclear matter are also studied. However, Nuclear physics should not be confused with atomic physics, which studies the atom as whole, including its electrons.(https://en.wikipedia.org/wiki/Nuclear_physics).[2]

Objectives of the Study

The main objective of the present study is to perform a Scientometrics analysis of nuclear science in India. The specific objectives of the study are to:

1. Find out the year wise growth of publications.
2. Study the journals preferred by the scientists.
3. Examine geographical distribution of research output.
4. Study the institutional productivity in the field of nuclear science.

5. Know the highly productive scientists.
6. Document type of distribution, and
7. Language wise distribution.

Materials and Methods

There are at present two citations databases, viz. Web of Science (WoS) and SCOPUS, wherein a scientist or a researcher can rely on these databases for citations. For the present study, the data was collected by using Web of Science (WoS), particularly Science Citation Index Expanded (SCI- expanded), for the duration 2009–2018. By using suitable search syntax, records pertaining to nuclear science in the web of science category field were downloaded for the period 2009–2018. WC = Nuclear was used as the search syntax. The data were collected in the month of August, 2019.

Results

Year wise growth and distribution of Publications on Nuclear Science

Table 1 shows that out of 10278 research papers, the highest number of papers i.e. 1189 (11.57%) are scholarly publications with 4530 citations with 3.81 average citations per papers and h-index is 23 in the year 2016. It is followed by 1179 (11.47%) publications with 2927 citations and 2.48 average citations per paper and h-index is 18 in the year 2017. The lowest number, i.e. 718 (6.99%) research output of 7,603 citations with 10.59 average citations per paper and h- index is 36 in the year 2009.

Table 1: Year wise growth and distribution of Publications on Nuclear Science

Year	TP	TC	ACCP	H-Index	%
2009	718	7,603	10.59	36	6.99
2010	802	8,516	10.62	38	7.80
2011	986	8,731	8.85	39	9.59
2012	1089	8,102	7.44	34	10.60
2013	1049	8,481	8.08	33	10.21
2014	1147	7,185	6.26	30	11.16
2015	1030	4,486	4.36	24	10.02
2016	1189	4,530	3.81	23	11.57
2017	1179	2,927	2.48	18	11.47
2018	1089	1,184	1.09	10	10.60
Total	10278	61,745			100

Distribution of research output in different subfields in Indian Nuclear Science

Table 2 indicates the top ten sub-fields in Indian Nuclear. Among the selected top ten publications contribution according to the highest research output is from Radiology Nuclear Medicine Medical Imaging (5589, 32.52 % share), followed by Nuclear Science Technology (5328, 31.00% share), Chemistry (1747, 10.16% share), Physics (1504, 8.75% share), Oncology (887, 5.16% share). Instruments, Instrumentation (863, 5.02% share), Materials Science (393, 2.29% share), Environmental Sciences Ecology (280, 1.51% share), Public Environmental Occupational Health with the share of (260, 1.51%) are among top ten contribution.

Table 2: Distribution of research output in different sub-fields in Indian Nuclear Science

Sl. No	Research Area	Records	%
1	Radiology Nuclear Medicine Medical Imaging	5589	32.52
2	Nuclear Science Technology	5328	31.00
3	Chemistry	1747	10.16
4	Physics	1504	8.75
5	Oncology	887	5.16
6	Instruments Instrumentation	863	5.02
7	Materials Science	393	2.29
8	Mathematical Computational Biology	336	1.95
9	Environmental Sciences Ecology	280	1.63
10	Public Environmental Occupational Health	260	1.51
	Total	17187	100

Most preferred journals in the field of Nuclear Science

The important leading journals preferred by the Scientists are Journal of Radio analytical and Nuclear Chemistry with 900 publications (18.60% share), followed by European Journal of Nuclear Medicine and Molecular Imaging with 525 publications (10.85% share), Nuclear Instruments Methods in Physics Research Section B Beam Interactions with Materials and Atoms with 457 publications (9.44% share), Nuclear Engineering and Design with 420 publications (8.68% share), Journal of Nuclear Medicine with 411 publications (8.49% share). They are followed by Nuclear Instruments Methods in Physics Research Section A Accelerators Spectrometers Detectors and Associated Equipment with 405 publications (8.37% share), Journal of Nuclear Materials with 393 publications (8.12% share), International Journal of Radiation Oncology Biology Physics with 363 publications (7.95% share), Radiation Physics and Chemistry

with 357 publications (7.38% share), Journal of Medical Imaging and Health Informatics with 336 publications (6.94% share).

Table 3: Most preferred journals in the field of Nuclear Science

Sl. No	Source Title	Records	%
1	Journal of Radioanalytical and Nuclear Chemistry	900	18.60
2	European Journal of Nuclear Medicine and Molecular Imaging	525	10.85
3	Nuclear Instruments Methods in Physics Research Section B Beam Interactions with Materials and Atoms	457	9.44
4	Nuclear Engineering and Design	420	8.68
5	Journal of Nuclear Medicine	411	8.49
6	Nuclear Instruments Methods in Physics Research Section A Accelerators Spectrometers Detectors and Associated Equipment	405	8.37
7	Journal of Nuclear Materials	393	8.12
8	International Journal of Radiation Oncology Biology Physics	363	7.95
9	Radiation Physics and Chemistry	357	7.38
10	Journal of Medical Imaging and Health Informatics	336	6.94
	Total	4840	100

Most prolific research institutions in the field of Nuclear Science

Table 4 shows the most prolific research institutions of India. It may be noted that Bhabha Atomic Research Centre, Mumbai contributed the highest i.e. 2151 (38.62%) publications, followed by All India Institute of Medical Science with 724 (13.00%) publications, Indira Gandhi Centre for Atomic Research, Kalpakam with 626 (11.24%) publications, Indian Institute of Technology with 467 (8.38%) publications, Tata Memorial Hospital with 449 (8.06%) publications, Postgraduate Institute of Medical Education and Research with 321 (5.76%) publications, Institute for Plasma Research with 255 (4.58%) publications, Homi Bhabha National Institute with 231 (4.15%) publications, Inter University Accelerator Centre with 171 (3.07%) publications, and Saha Institute of Nuclear Physics with 165 (165%) publications.

Table 4: Indian Institutions Contributions of Nuclear Science

Sl. No	Organizations	Records	%
1	Bhabha Atomic Research Centre	2151	38.62
2	All India Institute of Medical Science	724	13.00
3	Indira Gandhi Centre for Atomic Research	626	11.24
4	Indian Institute of Technology	467	8.38
5	Tata Memorial Hospital	449	8.06
6	Postgraduate Institute of Medical Education and Research	321	5.76
7	Institute for Plasma Research	255	4.58
8	HomiBhabha National Institute	231	4.15
9	Inter University Accelerator Centre	171	3.07
10	Saha Institute of Nuclear Physics	165	2.97
	Total	5570	100

Highly Productive Scientists in India

The Table 5 shows the highly productive scientists based on their publications, irrespective of their disciplines during 2009–2018 appeared in Web of Science. It is seen that Kumar, R. contributed the highest publications to the field of Nuclear, i.e. 568 publications with 21.05% followed by Kumar A. 321 publications with 11.90%, Bala C. 306 publications with 11.34%, Kumar S. 290 publications with 10.75%, Mittal B. R. 229 publications with 8.49%, Sharma P. 229 publications with 8.49%, Bhattacharya, A. 223 publications with 8.27%, Malhotra, A. 205 publications with 7.60%, Basu, S. 170 publications with 6.30%, and Singh, B. 157 publications with 5.82%.

Table 5: Most prolific Indian authors in Nuclear Science

Sl. No	Authors	Records	%
1	Kumar R	568	21.05
2	Kumar A	321	11.90
3	Bala C	306	11.34
4	Kumar S	290	10.75
5	Mittal BR	229	8.49
6	Sharma P	229	8.49
7	Bhattacharya A	223	8.27
8	Malhotra A	205	7.60
9	Basu S	170	6.30
10	Singh B	157	5.82
	Total	2698	100

Countries Contributions in NuclearScience

Table 6 depicts the international collaborative papers of India with the top 10 countries during 2009–2018. These countries published 10278 articles with India in the field of nuclear science. It may be noted that the largest number of collaborative publications (612 articles) of India in this research output was with United States with 28.32% share, followed by France, (254 articles with 11.75% share), Germany, (241 articles with 11.15% share), England, (200 articles with 9.25% share), Italy, (167 articles with 7.73% share), South Korea, (164 articles with 7.59% share), Japan, (149 articles with 6.89% share), Austria (139 articles with 6.43% share), Canada, (118 articles with 5.46% share), and Peoples R China, (117 articles with 5.41% share).

Table 6: Countries Contributions in Nuclear Science

Sl. No	Countries	Records	%
1	USA	612	28.32
2	France	254	11.75
3	Germany	241	11.15
4	England	200	9.25
5	Italy	167	7.73
6	South Korea	164	7.59
7	Japan	149	6.89
8	Austria	139	6.43
9	Canada	118	5.46
10	Peoples R China	117	5.41
	Total	2161	100

Distribution of publications among document types

The sources of nuclear sciences research include articles published in the journals, meeting abstracts, reviews, conference and seminars proceedings, editorial materials, corrections and book chapters (Table 7). This study has observed a total of 10278 publications in nuclear sciences from India over a period of ten years from 2009–2018. Out of them, articles appeared in the journals have shown a predominant contribution of 7670 publications with 69.48% share from countries. It is followed by the other research outputs falls in the meeting abstracts 1556 publications with 14.09% share, Proceedings Paper 758 publications with 6.86% share, Editorial Material 486 publications with 4.40% share, Letter 279 publications with 2.52% share, and Review 249 publications with 2.25% share.

Table 7: Distribution of publications among document types

Sl. No	Document Type	Record	%
1	Article	7670	69.48
2	Meeting Abstract	1556	14.09
3	Proceedings Paper	758	6.86
4	Editorial Material	486	4.40
5	Letter	279	2.52
6	Review	249	2.25
7	Correction	32	0.28
8	Biographical Item	5	0.04
9	Retracted Publication	2	0.01
10	Book Chapter	1	0.00
11	News Item	1	0.00
	Total	11039	100

Language wise Distribution

The Table 8 reveals the language wise distributions, of the paper made by scientists from their researchers is Indian Nuclear Science research are published in different language i.e. English, Spanish and German. It is observed that 10275 articles with 99.97% share published in English, 2 articles with 0.019% share in Spanish and 1 article with 0.009% share in German.

Table 8: Language Wise Distribution on Nuclear Science

Sl. No	Language	Records	%
1	English	10275	99.97
2	Spanish	2	0.019
3	German	1	0.009
	Total	10278	100

Discussion

A Scientometric analysis is also extremely important to plan appropriate measures to be taken to upgrade the research activities. Evaluation of research performance of major nuclear science research institutes of the country and to compare their performance among themselves and with similar institutes of other countries has become important. A detailed study of scientometric analysis of nuclear science research performance of India and its comparison with other countries has become essential to obtain a clear picture and to take necessary measures to upgrade the research performance.

Conclusion

It is observed from the present study that the journal articles published by the Indian Scientists in India during the period 2009–2018 as per the Web of Science database (WoS), India has produced 10278 research publications, and received 61745 citations during the period of 2009–2018. The paper gives an idea about the countries which are the most active in terms of scientific publications in nuclear science. This study highlights on the nuclear science and the author collaboration in this field. Further it is ssen that Indian nuclear science research literature has been gradually increased year by year.

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