



Mapping of Ultrasonic Research Output in India: A Scientometric Analysis

KEYWORDS

Ultrasonic, India, Scientometric, IF, collaboration coefficient, citation score

Suhashini Ernest

Associate Professor, Department of Physics, Urumu Dhanalakshmi College, Trichy

Kanchana S

Ph.D Scholar, Department of Physics, Urumu Dhanalakshmi College, Trichy

ABSTRACT

The study analyses the research output in India in Ultrasonic during the period 1999-2011 and the analyses included research growth, rank, Asian Countries publications' share, citation impact, share of international collaborative papers and major collaborative partner countries patterns of research communication in most productive journals. It also analyses the characteristics of most productive institutions, and authors. The publication output and impact of India also compared with USA, China, Japan, and South Korea

Introduction

The Main objective of this study is to analyze the research performance of India in ultrasonic's in national and global context, as reflected in the publications output during 1999-2011. In particular the study focused on: 1.Indian research output, its growth, rank, and global publications share and impact, 2.the patterns of international collaboration and major collaborative partners, 3.the publications productivity of leading institutions of India, 4.the characteristics of the most prolific authors and 5.the patterns of research communication in the most productive journals.

Materials and Methods:

This study is measured Indian publication productivity in the field of ultrasonic. The scientometric analysis is using the data downloaded from web of science and extracts the data's through histcite software. The sample during periods is 12 years (1999-2011). H-index derived from the database has been used to evaluate the research performance of top productive Indian institutions. H-index is a more rational method suggested by J.E.Hirsch to measure the scientific productivity and citation impact of an individual author or institution compared to simpler measures such as total number of citations or total number of publications.

Results:

Table 1: Growth Rate of ultrasonic research in Comprehensive level of Asia

Countries	No of Papers			% share of Papers			Publication Rank of Countries		
	1999	2011	99-2011	1999	2011	99-2011	1999	2011	99-2011
U.S.A	510	448	7197	24.9	17.2	20.46	1	2	1
China	94	532	4642	4.6	20.4	13.20	3	1	2
Japan	269	211	4062	13.1	8.1	11.55	2	3	3
India	81	167	1797	3.9	6.4	5.11	4	4	4
South Korea	43	18	1431	2.1	4.9	4.07	5	5	5
World	2047	2610	35160	5.8	7.4	-	-	-	-

The number of papers published from different countries during 1999-2011 is shown in the table. The USA is the leader, followed by china, Japan, India and South Korea. There has been a dramatic rise in ultrasonic research only in the new millennium in all the countries considered. USA accounted for 24.19% of the world's publication in 1999 followed by Japan 13.14%. Indeed, the republic of Chinese researchers (PRC) had overtaken Japan in 2011. India standing the same position among the Asian countries with publication share of 5.11% during 1999-2011. India's global publications share increased from 3.96% to 6.40% and also it ranking 4th place from 1999 to 2011. South Korea's global publication share even though increased from 2.10% to 4.90% it ranks 5th place from 1999 to 2011.

Table 2: Distribution of Ultrasonic Research Output in Indian Institutions (Top 15 Institutions)

Institutions	TP	TC	ACPP	H-Index
Indian Institute of Technology	163 (9.07)	955	5.86	14
Indira Gandhi Center for Atomic Research Institute	83 (4.61)	454	5.47	12

University of Allahabad	61 (3.39)	473	7.75	11
Annamalai University	57 (3.17)	184	3.22	6
Indian Institute of Science	56 (3.11)	578	10.32	14
Kurukshetra University	53 (2.94)	437	8.24	11
Osmania University	44 (2.44)	208	4.73	7
Saurashtra University	42 (2.33)	174	4.14	6
Jamia Millia Islamia	32 (1.78)	518	16.19	11
University of Delhi	29 (1.61)	332	11.45	10
University of Bombay	28 (1.55)	816	29.14	16
Bhabha Atomic Research Center	27 (1.50)	90	3.33	5
National Institute of Technology	27 (1.50)	92	3.41	5
Institute of Chemical Technology	26 (1.44)	107	4.11	7
University of Lucknow	26 (1.44)	167	6.42	6

The top 15 most productive Indian institutions involved in research in ultrasonics have published more papers during 1999-2011. The list of these Indian institutions along with their research output, citations are presented in table. Only six Indian institutions have registered higher publications

share than the group's average. These were Indian institute of Technology (IIT), with (163 papers), followed by Indira Gandhi Center Atom.1 research (IGCAR), Chennai with (83 papers), University of Allahabad, Allahabad (with 61 papers), Annamalai University, Chidambaram (with 57 papers), Indian Institution of Science(IISC), Bangalore (with 56 papers) and Kurukshetra University, Kurukshetra (with 53 papers). The other institutions such as Osmania University, Hyderabad (with 44 papers), Saurashtra University, Gujarat (with 42 papers), Jamiamilla Islamia, New Delhi (with 32 papers), University of Delhi, Delhi (with 29 papers), University of Bombay, Mumbai (with 28 papers), Bhabha Atomic Research Center, Mumbai (with 27 papers), National Institute of Technology, Trichy (with 27 papers), Institute of chemical Technology, Hyderabad (with 26 papers) and University of Lucknow, Lucknow (with 26 papers). Among these 15 institutions University of Bombay has scored the highest impact of 29.14 citations per paper, followed by Jamiamillia Islamia, New Delhi (with 16.19 citations per paper), University of Delhi (with 11.45 citations per paper), Indian Institute of Sciences, Bangalore (with 10.32 citations per paper) and Kurukshetra University (with 8.24 citations per paper).

The average H-index value of these 15 most productive Indian institutions is 9.4. Eight Indian institutions have scored higher H-index value than group's average of 9.4. This Institutions are Indian Institute of Technology, Indira Gandhi Center for Atomic Research Institute, University of Allahabad, University of Allahabad, Indian Institute of Science Kurukshetra University, Jamia Millia Islamia, University of Delhi, University of Bombay.

Table 3: International Collaborative countries with India in the ultrasonic research output

Country	TP	TC	ACPP
USA	32	498	15.56
Germany	18	144	8.0
Unknown	14	70	5.0
Australia	13	84	6.46
South korea	11	84	7.64
UK	11	177	16.09
France	10	152	15.2
Japan	10	109	10.9
Malaysia	7	13	1.86

Based on the publications data, the total collaborative papers during 1999-2011 consisted of 1797 papers with Average citation per paper is 6.96% compared to India, USAs International collaborative share output 1999-2011 was 15.56% (with 32 collaborative papers), followed by Germany with a8.0% share (with 18 collaborative papers), unknown with a 5.0% share (with 14 collaborative papers) and Australia with a 6.46% share (with 13 collaborative papers). Indias share of International collaborative papers in its total research output in ultrasonic showed significant increase during 1999-2011. total share of Southkorea was 7.64% (with 11 collaborative papers), UK was 16.09% (with 11 collaborative papers), France was 15.2%(with 10 collaborative papers), Japan was 10.9% (with 10 collaborative papers) and Malaysia was 1.86% (with 7 collaborative papers).

Table 4: most productivity journals in ultrasonic research output with IF (Top 15 journals)

Journal	TP	TC	ACPP	IF (2010)
Indian Journal of Pure and Applied Physics	105	656	6.24	0.511
Journal of Molecular Liquids	77	529	6.87	1.649
Ultrasonics Sonochemistry	68	917	13.48	3.203
Physics and Chemistry of Liquids	58	324	5.58	0.555
Indian Jrl. of Chemistry Sec. A- Inorganic Bio-Inorganic Physical Theoretical & Analytical Chemistry	49	265	5.40	0.920
Asian Journal of Chemistry	44	265	6.02	0.920
Journal of the Indian Chemical Society	40	86	2.15	0.301
Journal of Chemical Thermodynamics	36	349	9.69	2.794
Journal of Chemical and Engineering data	34	280	8.23	2.089
Fluid Phase Equilibria	28	302	10.78	2.253
Materials Letter	27	179	6.62	2.120
Journal of Applied Polymer Science	26	171	6.57	1.240
Journal of Solution Chemistry	24	176	6.76	1.335
Insight	23	72	3.13	0.431
Bulletin of Materials Science	18	86	4.77	0.944

The journals used most often by Ultrasonic researchers in India are listed in Table 3 along with their 2010 IF (IFs). - Virtuallyresearchers from India considered publish most of their work in the same set of international journals such as Indian Journal of Pure and Applied Physics, Journal of Molecular Liquids, Ultrasonics Sonochemistry, Physics and Chemistry of Liquids with some minor variations in the extent of use. Indian researchers have published 105 papers in Indian Journal of Pure and Applied Physics [India, 20010 IF 0.511] As Ultrasonic is a hot field of research, papers in the field tend to appear in high IF journals: 68 papers have appeared in Ultrasonics Sonochemistry journal with IFs higher than 3.000, and 458 papers have appeared in journal of Chemical Thermodynamics journal with an IF 2.794.

Dominant Authors

Table 6 shows that the most productivity authors with their

affiliation in the area of ultrasonic research. First 15 authors only taken here for analysis, Out of 15, six authors from Tamil nadu, 2 from Maharastra, 2 from UP, 2 from New Delhi and each 1 from Rajasthan, Haryana and Shimla.

These 15 authors together have contributed 618 papers, with an average contribution of 40 papers per author. Among the 15 most productive authors, only six authors have published higher number of papers than the group's average. These are Kumar A (MP Govrnment PG College, Madhya Pradesh) is the most prolific Indian researcher in this field. He has published 71 papers from India during 1999-2011and these were cited 396 times for an average of 17 citations per paper. Balasu bramaniam K (IIT Madras; 60 papers and 179 citations), Raj B (Indira Gandhi Control Atomic Research Institution,; 59 papers and 327 citations), Jayakumar T (Indira Gandhi Control Atomic Research Institution 58 papers and 298 citations).

Table 5: List of dominant Authors Published in Ultrasonic research

S. No.	Author	Affiliation with Department	State	TP	TC	ACPP
1	Kumar A	MP Govt PG College Dept Chemistry	Madhya Pradesh	71	396	5.58
2	Balasu bramaniam K	IIT - Madras, Dept Mechanical Engineering	Tamilnadu	60	179	2.98

3	Raj B	Indira Gandhi Central Atomic Research, Qual Assurance Division.	Tamilnadu	59	327	5.54
4	Jayakumar T	Indira Gandhi Central Atomic Research, Met & Mat Grp, Div Physics Met.	Tamilnadu	58	298	5.14
5	Pandit AB	Institute Chemical Technology, Dept Chemical Engineering.	Maharashtra	52	1360	26.15
6	Gogate PR	Institute Chemical Technology, Dept Chemical Engineering.	Maharashtra	50	1107	22.14
7	Krishnamurthy CV	Indian Institute Technology Madras, Dept Physics.	Tamilnadu	38	120	3.15
8	Nain AK	University of Delhi, Dept Chemistry, Dyal Singh College.	New Delhi	34	493	14.5
9	Pal A	Kurukshetra University, Department Chemical.	Haryana	34	229	6.74
10	Ali A	Cent University, Dept Chemical	New Delhi	33	479	14.15
11	Rajendran	KS Rangasamy College of Technology, Centre for Nano Science and Technology.	Tamilnadu	32	219	6.84
12	Pandey JD	University Allahabad, Dept Chemical.	Uttar Pradesh	26	180	6.92
13	Roy MN	N Bengal University, Dept Chemical.	Shimla	25	147	5.88
14	Kannappan V	Presidency College, Dept Chemical.	Tamilnadu	24	80	3.33
15	Shukla JP	University Lucknow, Department Physics	Uttar Pradesh	22	117	5.31

Collaborative Index and Collaboration Coefficient

Collaborative Index can be obtained by total number of authors divided by total number of published articles. Collaborative Index = total number of authors / Total number of articles Where, CI = It is the number of authors per paper. Result from the above table is showed that Authorship pattern and collaborative measures. The collaborative Index for Indian level is 3.24 which show that collaborative research pattern is more than solo research.

Authorship Pattern

The table 7 shows the authorship pattern (single, double, triple, etc... till eleven authors) of research publication in the field of ultrasonic. 5827 authors were contributed in 1797 articles. 1.58 percent of authors were one single status. Remaining 98 percents of authors were collaborating status. Among these joint authors, three authors contribution is very high (26.26%), followed by four author's contribution (25.67%), double authors collaboration (18.43%) respectively. The degree of collaboration is defined as the ratio of the number of collaborative research papers to the total number of research papers in the discipline during a certain period of time. The formula suggested by Subramanyam (1983) is used. Based on this study, the result of collaboration coefficient C = 0.98. i.e, 98 % of collaborative author's articles is published in this study.

Table 6: Authorship pattern with collaboration coefficient

No of Authors	No. of Articles	Authorship	Percents
1	91	91	1.58
2	537	1074	18.43
3	510	1530	26.26
4	374	1496	25.67
5	171	855	14.67
6	59	354	6.07
7	29	203	3.48
8	16	128	2.20
9	6	54	0.93
10	2	20	0.34
11	2	22	0.38
Total	1797	5827	100
CC	0.98		

Table 7: Word frequency occurrence in the selected data (first 15 words only)

S.No	Word occurrence	Recs.	TLCS	TGCS
1	Ultrasonic	770	8	3843
2	Mixtures	296	3	1707
3	Binary	230	1	1436
4	Liquid	207	1	910
5	Velocity	139	0	793
6	Rid	137	0	476
7	Temperatures	130	1	621
8	Molecular	118	2	2149
9	Interactions	112	1	538
10	Ultrasound	103	3	703
11	Acoustic	87	0	311
12	Viscosity	86	0	591
13	Thermodynamic	84	3	586
14	Water	72	1	371
15	Acoustical	68	1	352

The table 7 represents the word wise distribution of research output on Ultrasonic research. The word Ultrasonic was the most occurred word. It had occurred 770 times (31.4%) in the research output, TLCS-8 and TGCS-3843. The second most occurred word is Mixtures accounted to 296 times (22.2%) in the research publications, TLCS-3 and TGCS-1707 and followed by Binary, Liquid, Velocity.

Conclusion:

India is far behind USA, Japan, China, in terms of publication output, citation quality in ultrasonic research. There is an urgent need for substantial increase in research and development investments, both at the institutional level as well as in terms of extramural funding from different scientific agencies. Academic institutes should take steps to create interest in research in ultrasonic among graduate and postgraduate students and also among young scientists. Such efforts should include specialized training programs with support from funding agencies. In addition, existing training programs at the institutional level need to be strengthened, besides building new and more comprehensive training programs to develop manpower needs. There should be a substantial increase in international collaboration to increase the output and also to improve the quality of research. In addition there should be more collaboration among the Indian institutions.

REFERENCE

1. Arunachalam, Subbiah, Garg, Kailash C (1986). "Science on the Periphery: A Scientometric analysis of Science in the Asian Countries", *J. Inf. Sci. Principles and Practice* (Amsterdam), 12(3): 105-11 | 2. Balasubramani (2011) | 3. Garfield, G., Soren, W. P. and Stock, W. G., *HistCite: A software tool for informetric analysis of citation linkage*. *Information*, 2006, 57, 391-400. Also see www.histcite.com | 4. Swarna T, Kalyane VL, Kumar V(2002). "Scientometric dimensions of technical reports from Bhabha Atomic Research Centre", *Malaysian J. Libr. Inf. Sci.* 7(1): 17-30. | 5. Kaur, Har and Gupta, B (2010) Mapping of dental science research in India: a scientometric analysis of India's research output, 1999-2008. *Scientometrics*; Oct2010, Vol. 85 Issue 1, p361-376, 16p | 6. Pouris, Anastassios (2010) A scientometric assessment of the Southern Africa Development Community: science in the tip of Africa. *Scientometrics*; Oct2010, Vol. 85 Issue 1, p145-154, 10p | 7. Khurshid, A. and Sahai, H. (1991)"Bibliometric, scientometric and informetric distributions and laws: a selected bibliography", *International Forum on Information and Documentation*, Vol. 16, No. 2, pp. 18-29. |