

Scientometric Analysis of Astronomy and Astrophysics Research in India: A Study based on Web of Science

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Abstract

The purpose of this study is to assess the research productivity of Astronomy and Astrophysics research in India. The bibliographical data were harvested from Web of Science (WoS) database for the period of 15 years from 2001 to 2015. 12,144 research papers has been published by the Indian astrophysicist in which 10,746 research publications are in referred journals and 1398 research publications are in conferences, symposiums, bulletins, book chapters etc. The paper reveals about the publications frequencies, CAGR, open access publications, prolific Institutions as well as Authors, preferred journal, Authorship pattern and prolific research collaborating countries with India in the field of Astronomy and Astrophysics.

Keywords: Bibliometrics, scientometrics, research productivity, astronomy and astrophysics, Web of Science, India

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INTRODUCTION

The evaluation of research productivity of an individual, institution, region or country based on counting of research papers and citations are well known technique in studies of science and technology, for research policy making, identification and assessment of the potency and deficiency in scientific achievements. As progress in scientometric indicators like publication profile of research institutions, individuals, countries etc. are closely related to overall research and development of a country. Scientometric studies are primarily intended to identify, compare and evaluate relevant aspects of input and output of scientific productivity and research in more objectives that is quantitative fashion [1].

Assessing scientific efficiency and impact of various subject areas, countries, authors, institutions, etc. is one of the goals of bibliometric or scientometric studies. The efficiency and impact has been evaluated through numerous indicators including number of citations, h-index, g-index, i10 and so on. Assessment and interpretation plays vital role in decision and policy framing about each area of science and provide useful information about the status of that domain and its potency and

deficiency. Using numerical techniques like bibliometrics, numerous studies have been conducted in different subject field and impact from various aspects during different period [2].

During the last few years, several bibliometric studies have been done to assess the research productivity of different countries, institutions and individuals. Wang, Fu and Ho [3] assessed scientific productivity of National Taiwan University (NTU) and Peking University (PKU) during 2000–2009 in terms of publication, compared it using scientometric indicators and shown the publication outputs, publication patterns and inter-institutional collaborations of the two universities.

Meena and Nagarajan [4] assessed Indian malaria research publications during 1974–2013 using different bibliometric indicators. The study described the pattern of growth of research output, its collaboration with other countries in different subfields. Mishra and Sarangi [5] used bibliometrics evaluators for IITs and NITs (during 2012–2014) and ranked these technology institutes as per the citations received for their research papers and faculty h-index.

Jain and Garg [6] assessed Laser research in India; Joshi et al. [7] evaluated the forest fungal research; Garg et al. [8] on Japanese Encephalitis research and Dwivedi, S. et al. [9] evaluated organic chemistry research of India. These researchers had analyzed the research data and found a meaningful result that may attract the concern stake holder and policy makers in their field of interest.

OBJECTIVES

The objectives of the study are as follows:

1. To study the growth of Astronomical research publication of India during 2001–2015.
2. To examine the sub-discipline coverage Astronomical and Astrophysics research.
3. To examine most prolific author, citations and H-Index.
4. To study the most prolific Institute engaged in Astronomical research.
5. To map the highly productive source journals.
6. To find out India’s collaborating countries in Astronomy and Astrophysics research.
7. To find out the Authorship pattern in Astronomy and Astrophysics research in India.

DATA SOURCE AND METHODOLOGY

The Data was retrieved from Web of Science—SCIE bibliographical database (A product of Thomson Reuters now Clarivate Analytics). Data retrieved with the help of advance search term SU = (Astronomy and Astrophysics) and the period was selected 2001–2015. Total result found for the world was 3, 33,509. Further data was refined with country name ‘INDIA’ and 12, 144 records were received for the Astronomical research in India for the current study.

DATA ANALYSIS AND INTERPRETATION

India’s Position in Astronomy and Astrophysics Research

USA is the world’s major contributor in the field of Astronomy and Astrophysics and has contributed 40.49% with number one rank. Germany 15.76%, England 12. 63%, France 11.15%, and Italy 10.32% holds second, third, fourth and fifth ranks respectively. India holds

13th rank with 12,144 (3.63%) research publication in the field of Astronomical research in the world (Table 1).

Table 1: World ranking of most productive countries.

Rank	Country	Publications	Percentage (%)
1.	USA	1,35,068	40.49%
2.	Germany	52,569	15.76%
3.	England	42,138	12. 63%
4.	France	37,178	11.15%
5.	Italy	34,422	10.32%
6.	Japan	26,121	7.83%
7.	Spain	23,694	7.11%
8.	Russia	22,690	6.80%
9.	China	20,997	6.29%
10.	Canada	17,964	5.39%
11.	Netherlands	15,141	4.54%
12.	Australia	13,025	3.91%
13.	India	12,144	3.63%
14.	Switzerland	11,486	3.44%
15.	Chile	10,026	3.01%
World’s Total Astronomical Publication (During 2001–2015)		3,33,509	

Growth of Research Output Over the Years

Astronomy and Astrophysics research has increased in a sizable number of publications during the period of 15 years. Minimum 488 publications was in 2004 and maximum 1220 publications shown in 2014. The graph shows continuous increase from 2008 to 2014. In the year 2002, 2003, 2004, 2007 and 2015 had decreased of publication that was too minimal which can be ignored. Over all the research publications are growing (Figure 1).

The Compound Annual Growth Rate (CAGR) has been calculated with the **Formula: CAGR= (Ending Value/Beginning Value)^{1/n} -1**(Choi, D.G. et al., 2011) [10] and found 5.25% was the average CAGR of Indian Astronomical research publications.

India’s publication has grown over the years. Year 2002, 2003, 2004, 2007 and 2015 had negative Compound Annual Growth Rate (CAGR) that is -6.23%, -6.84%, -0.41%, -2.46% and -0.90% respectively. The highest CAGR recorded in the year 2005 (29.71%). The average CAGR is 5.25% (Table 2).

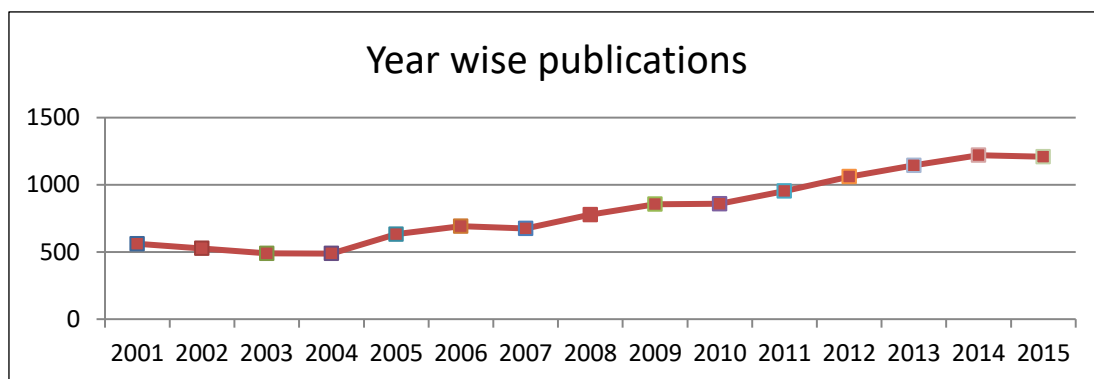


Fig. 1: Year wise productivity in publications.

Table 2: Compound Annual Growth Rate in Publications.

*CAGR= Compound Annual Growth Rate

Year	Publications	CAGR*
2001	561	-
2002	526	-6.24%
2003	490	-6.84%
2004	488	-0.41%
2005	633	29.71%
2006	692	9.32%
2007	675	-2.46%
2008	778	15.26%
2009	855	9.90%
2010	859	0.47%
2011	953	10.94%
2012	1060	11.23%
2013	1145	8.02%
2014	1220	6.55%
2015	1209	-0.90%
Total	12,144	5.25%

Type of Publications

India has published 36.65% of Astronomical research in open access journals and paid access journal publications are 63.35% (Table 3).

Table 3: Category of publications.

Type of Publications	No. of Publications	Percentage
Open Access Publication	4,451	36.65%
Subscription/paid access Publications	7,693	63.35%
Total	12,144	100%

Type of Documents

India has published 88.5% of the research papers as journal articles, 12.49% of the scholarly publication was as conference papers,

1.25% as review articles. The other publications are meeting abstract 0.60%, correction 0.47%, editorial 0.33%, letter 0.18% and book chapters 0.05% (Table 3).

Table 4: Type of documents published.

Document Type	Numbers	Percentage
Journal Articles	10,746	88.5%
Conference Proceeding papers	1,517	12.49%
Review	152	1.25%
Meeting Abstract	73	0.60%
Correction	57	0.47%
Editorial	40	0.33%
Letter	22	0.18%
Book Chapter and others	6	0.05%

Subject Wise Research Coverage

Table 5: Subject wise research publication's coverage.

Subject	No. of Publications	Percentage (%)
Physics -Particles Fields	4579	37.71%
Physics -Nuclear	1219	10.1%
Meteorology, Atmospheric sciences	787	6.48%
Geosciences	768	6.32%
Multidisciplinary	554	4.56%
Physics Multidisciplinary	554	4.56%
Instrumentation	144	1.19%
Engineering Aerospace	140	1.15%
Geochemistry	97	0.80%
Geophysics	97	0.80%
Remote sensing	82	0.68%
Telecommunications	65	0.54%
Physics—Fluids Plasmas	62	0.51%
Optics	51	0.42%
Physics—Fluids Plasmas	41	0.34%
Information Science	35	0.29%
Chemistry - Multidisciplinary	23	0.19%

Table 5 shows the top 15 sub-field of research were most of the research articles of Astronomy and astrophysics have been published by the Indian Astronomical scientist. Physics—Particles Fields 4579 (37.71%) articles, Physics—Nuclear 1219 (10.1%) articles and Meteorology, Atmospheric sciences 787 (6.48%) articles holds 1st, 2nd and 3rd ranks in the research publication respectively (Table 5).

Most Preferred Journals

Table 6 shows that Physical review ‘D’ is the top most preferred publishing journal for the publication by the astronomical scientist of India followed by Physical Letters ‘B’, MNRAS, Astrophysics and Space Science, Astrophysical Journal, Astronomy and Astrophysics and so on. Top 15 journals have published more than 80% of the research articles (Table 6).

Prolific Institutions

TIFR Mumbai is the most prolific research institution with 2252 (18.54%) research publications followed by IUCAA, IIA, PU, PRL, SINP, ARIES, RRI, IISc and HRI. The top ten institutions have produced more than two-third papers out of the gross publications of India during the period 2001–2015 (Table 7).

Prolific Authors

Banerjee S. is the most productive author from India who has published 638 research papers and has 23,475 citations with H-Index of 64. All of the prolific authors are from prominent institutions of India. Out of ten, two authors are from TIFR, two from Punjab University and again two from SNIP, Kolkata, four authors are from University of Delhi. All the authors have very high citations and have H-Index more than 50 (Table 8).

Table 6: Most prolific journals.

S. No.	Name of the Journal	Publications	Percentage
1.	Physical Review ‘D’	2446	20.14%
2.	Physics Letters ‘B’	1162	9.57%
3.	Monthly Notices Of The Royal Astronomical Society (MNRAS)	1161	9.57%
4.	Astrophysics and Space Science	912	7.51%
5.	Astrophysical Journal	858	7.1%
6.	Astronomy and Astrophysics	760	6.26%
7.	Advances in Space Research	388	3.19%
8.	International Journal Of Modern Physics ‘D’	314	2.59%
9.	Journal of Geophysical Research Space Physics	310	2.55%
10.	Classical and Quantum Gravity	299	2.46%
11.	Annals Geophysicae	273	2.25%
12.	Astronomical Society of the Pacific Conference Series	242	1.99%
13.	Solar Physics	231	1.90%
14.	Journal of Astrophysics And Astronomy	213	1.75%
15.	General Relativity And Gravitation	190	1.56%

Table 7: Most productive institutions.

S. No.	Name of the Institution	Publications	Percentage
1.	Tata Institute of Fundamental Research (TIFR), Mumbai	2252	18.54%
2.	Inter University Centre for Astronomy Astrophysics (IUCAA), Pune	1266	10.42%
3.	Indian Institute of Astrophysics (IIA), Bangalore	1124	9.26%
4.	Panjab University (PU), Chandigarh	799	6.58%
5.	Physical Research Laboratory (PRL)	768	6.32%
6.	Saha Institute of Nuclear Physics (SINP)	587	4.83%
7.	Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital	574	4.73%
8.	Raman Research Institute (RRI) Bangalore	563	4.64%
9.	Indian Institute of Science (IISc) Bangalore	416	3.42%
10.	Harish Chandra Research Institute (HRI) Allahabad	387	3.18%

Table 8: Most productive authors.

S. No.	Name of the Author	Affiliation	Publications	Citations	H-Index
1.	Banerjee S.	TIFR, Mumbai	638	23,475	64
2.	Kumar A.	Univ. of Delhi	398	17,929	58
3.	Bhatnagar V.	Punjab Univ.	367	16,732	54
4.	Beri, SB	Punjab Univ.	352	15,997	53
5.	Mohanty, GB	TIFR, Mumbai	304	14,187	54
6.	Ranjan K	Univ. of Delhi	304	15,131	53
7.	Shivpuri, RK	Univ. of Delhi	297	14,883	52
8.	Naimuddin, M	Univ. of Delhi	295	14,732	52
9.	Sarkar, S	SINP, Kolkata	283	25,489	56
10.	Jain, S	SINP, Kolkata	276	14,441	52

Table 9: Most collaborative countries.

S. No.	Name of the research collaborating country	Publications	Percentage
1.	USA	3251	26.77%
2.	Germany	1951	16.07%
3.	France	1574	12.96%
4.	Russia	1444	11.89%
5.	England	1407	11.59%
6.	Italy	1217	10.02%
7.	China	1118	9.21%
8.	Spain	1088	8.96%
9.	South Korea	1067	8.79%
10.	Japan	1047	8.62%

Table 10: Authorship pattern in publications

Year	One Author	Two Author	Three Author	More than Three Author	Total
2001	94	175	134	158	561
2002	90	147	150	139	526
2003	88	142	93	167	490
2004	54	152	112	170	488
2005	91	152	154	236	633
2006	98	165	163	266	692
2007	82	155	148	290	675
2008	102	181	173	322	778
2009	88	184	201	382	855
2010	114	186	175	384	859
2011	99	231	198	425	953
2012	98	239	226	497	1060
2013	122	252	224	547	1145
2014	111	310	220	579	1220
2015	89	259	263	598	1209
Total	1420(11.69%)	2930(24.13%)	2634(21.69%)	5160 (42.49%)	12,144(100%)

Top 10 Research Collaborating Country

India's top collaborating country in the field of Astronomical research is USA followed by Germany, France, Russia and So on. Out of ten, top 8 collaborating countries are from western countries and only china and South Korea is from Asian countries which are too good researcher country in the world. Over all India

is collaborating with leading researcher countries of the world (Table 9).

Year wise Authorship Pattern

India has published 1420 (11.69%) research publications in single authorship, 2930 (24.13%) publication in two authorship, 2634 (21.69%) papers in three authorship and

remaining publications, i.e., 5160 (42.49%) in more than three authorship (Table 10).

It indicates that multi-authorship research or collaborative research effort are more attentive in Astronomy and Astrophysics research in India during the year 2001–2015. The single authorship is very less but ‘two authorship’ is more than ‘three authorship’. The Scientists are more involved in collaborative research than individual research.

CONCLUSIONS

This study discovers Scientometric analysis of Indian Astronomy and Astrophysics research as reported in *Web of Science (WoS)* bibliographical database [11]. The study reveals that Astronomy and Astrophysics research in India is growing year after year. India is holding 13th rank in the field of Astronomy and Astrophysics research in the world. The research performance has shown a steady growth since 2008 and maximum hike occurred in 2014. India has published 36.65% of Astronomy and Astrophysics research in open access journals and 63.35% in paid access journals. India has published 88.5% of the research papers as journal articles. TIFR is the most prolific institution whose Scientist - Banerjee S. is the most prolific author. India is collaborating with leading and developed researcher countries of the world. The collaborative research is most preferred and focused as multi authorship pattern of publications. It can be said from the above analysis that India is moving in the positive direction with a steady growth but more improvement is needed to come up in the top rank with more number of publications.

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