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Winter 8-8-2015

# Research Productivity of the scientists of Indira Gandhi Centre for Atomic Research (IGCAR) Kalpakkam (Chennai): A Scientometric Analysis

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Ramalingam, Jeyshankar -. -, "Research Productivity of the scientists of Indira Gandhi Centre for Atomic Research (IGCAR) Kalpakkam (Chennai): A Scientometric Analysis" (2015). *Library Philosophy and Practice (e-journal)*. 1294.  
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**Research Productivity of the scientists of Indira Gandhi Centre for  
Atomic Research (IGCAR) Kalpakkam (Chennai):  
A Scientometric Analysis**

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***Abstract***

*The present study evaluates the research publication trend among scientists of Indira Gandhi Centre for Atomic Research during the period 1989-2013. Data were analyzed based on type of publication, year of publication, language, source, country, institutions, most preferred journals and most prolific authors among other variables. The study revealed that majority (96.26%) of the researchers preferred to publish their research papers in joint authorship only and the degree of author collaboration ranges from 0.84 to 0.99 and its mean value is 0.95. It also revealed that IGCAR scientists preferred to publish their work in the Journal of Nuclear Materials and Transactions of the Indian Institute of Metals. The top three collaborative institutions with IGCAR are Indian Institute of Technology, Chennai, Bhabha Atomic Research Centre, Mumbai and Anna University, Chennai.*

**Keywords:** *Research Productivity, Degree of Collaboration, RGR & Dt, Scientometric, and Pattern of Co-authorship and Scientometrics*

**Introduction**

Scientometrics is the study of the quantitative aspects of science as a discipline or economic activity. It is part of the sociology of science and has application to science policy-making. It involves quantitative studies of scientific activities including among others, publication and so overlaps bibliometrics to some extent (Tague, 1992)<sup>1</sup>. Research publications are clearly one of the quantitative measures for the basic research activity in a country. It must be added, however, that what excites the common man, as well as the scientific community, are the peaks of scientific and technological achievement, not just the statistics on publications (Chidambaram, 2005)<sup>2</sup>. Scientometric evaluation is one of the key components of any research and development activities. This study mainly focused on scientometric indicators that are used to evaluate the research publication trend among the

scientists of IGCAR. It examines the research output, authorship trend and Institutional collaboration, country-wise distribution, core periodicals and author productivity and so on.

## **IGCAR**

Indira Gandhi Centre for Atomic Research [IGCAR], the second largest establishment of the Department of Atomic Energy next to Bhabha Atomic Research Centre, was set up at Kalpakkam, in 1971. The main objective of conducting broad based multidisciplinary programme of scientific research and advanced Engineering, directed towards the development of sodium cooled Fast Breeder Reactor [FBR] technology, in India. In addition, it is a part of the second stage of Indian Atomic Energy Programme, which is aimed at preparing the country for utilization of the extensive Thorium reserves and providing means to meet the large demands of electrical energy in 21st century. Over the years, the centre has established comprehensive research and development facilities and has developed a strong base in a variety of disciplines related to the advanced technology. The institute having collaborations with educational and R & D institutes like Indian Institutes of Technology, Indian Institute of Science, Pilani, Regional Engineering Colleges, National Research Laboratories, Public Units and Institutes abroad. IGCAR provides modern library services and it comprises 62,000 volumes of books, 28,400 back volumes, about 785 journals and 1.95 lakhs reports in all disciplines caters to the technical needs of the scientists and engineers<sup>3</sup>.

### **Objective of the Study**

- To identify the research output by the scientist of IGCAR, Kalpakkam covered in the SCOPUS during 1989-2013;
- To examine and analyse the authorship pattern in atomic research in IGCAR;
- To determine the growth rate and degree of collaboration of scientist in IGCAR, and
- To identify the most prolific authors, preferred journals , country-wise and institution –wise collaboration.

## Literature Review

Sharma (2009)<sup>4</sup> evaluated the research performance among scientists of Central Potato Research Institute (CPRI). The study found that majority of scientists preferred to work in collaboration and publish research papers in joint authorship (82.67) and degree of collaboration is 0.82%.

Jeysankar, Ramesh Babu and Rajendran (2011)<sup>5</sup> analysed bibliographical details of 1282 research articles published by the scientists of CECRI during the period 2000-2009. The study revealed that the most productive publications (15.13%) are published in the year of 2009 and collaborative research was dominant with the highest degree of collaboration being 0.98, in the year 2005.

Lee (2003)<sup>6</sup> investigated the research performance of the Institute of Molecular and Cell Biology (IMCB). The study analysed in the ten years, IMCB produced 395 research papers, 33 book chapters, 24 conference papers, and 4 monographs, graduated 46 PhDs, and filed 10 patents. It found that articles received an average of 25 to 35 citations per article, and the percentage of non cited articles is 11.06%.

Le Minor and Dostatni (2003)<sup>7</sup> compiled an inventory of the French National Institute for Health and Medical Research's (INSERM) publications by querying MEDLINE and the *Science Citation Index* (SCI). They found that 20% of INSERM's publications appeared in French journals and 80% in international ones (33% from the United States and 45% from Europe).

Vinkler (1998)<sup>8</sup> assessed the activities of the research institutes of the Hungarian Academy of Sciences with the goal of characterizing the activities of the institutes during 1992-1995. This study was done to aid the restructuring of the institutional network of the Academy.

Mini Devi and Lekshmi (2014)<sup>9</sup> evaluated the publication productivity of Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) during 2001-2010. They found that scientists of JNTBGRI preferred mostly Indian journals to publish their articles and India is the leading country with 54.67 % of total journals.

Seema (2011)<sup>10</sup> investigated the contribution and impact of research output of PEC University of Technology covered in *Scopus* database. The study analysed 177 research papers published during 14 years period, i.e., from 1996 to 2009, by the

nine departments of the PEC showing an annual average growth rate of 131.85 per cent. Growth in the academic research output was seen after the PEC has acquired the deemed university status. Contribution to engineering and technology literature from this institute was steadily increasing since then.

Bhatia (2010)<sup>11</sup> analysed the publication productivity of National Institute of Occupational Health (ICMR) Ahmadabad, India, during 2000–2006. The result displayed that more publications are observed in journals dealing in occupational health and occupational medicine, which is related to institutional research field. Multiple-authored articles are more than single-authored articles because research format in occupational health is multi-disciplinary.

Aswathy and Gopikuttan (2013)<sup>12</sup> investigated publication pattern of faculty members of three universities in Kerala viz., University of Kerala, Mahatma Gandhi University and University of Calicut. The study showed that Multi-authorship dominated among university teachers and there was no statistically significant difference between the experience and productivity. Designation-wise Degree of Colloboration showed that professors had a high Degree of Colloboration which indicated that increased in the age and experience resulted in more collaborative papers.

### **Data Source, Limitations and Methodology**

The data for the present study were pooled from Scopus international database and it's covered 53 million records, 21,915 titles and 5000 publishers. The bibliographic details of the published literature were collected using general search option of *Scopus*. The database searched under the address heading University or Institution - 'Indira Gandhi Centre for Atomic Research' research in the field of Search Box. The search was limited for a period of twenty five years from 1989 to 2013, 5171 records were retrieved from Scopus database only, even though some of the publications were not covered in this database. Thus a total of 5171 records of different type viz. articles (4217), conference papers (774), reviews (76), article in press (48) letters (17), notes (11), editorials (9), erratum (7), books (5), book chapters (3), short surveys (2), conference review (1) and undefined (1) were retrieved. The collected data were analysed using MS Excel and subjected to further analysis to meet the objectives and some scientometric indicators such as; Relative

Growth rate and Doubling Time, Degree of Collaboration, Pattern of Co-authorship had been used.

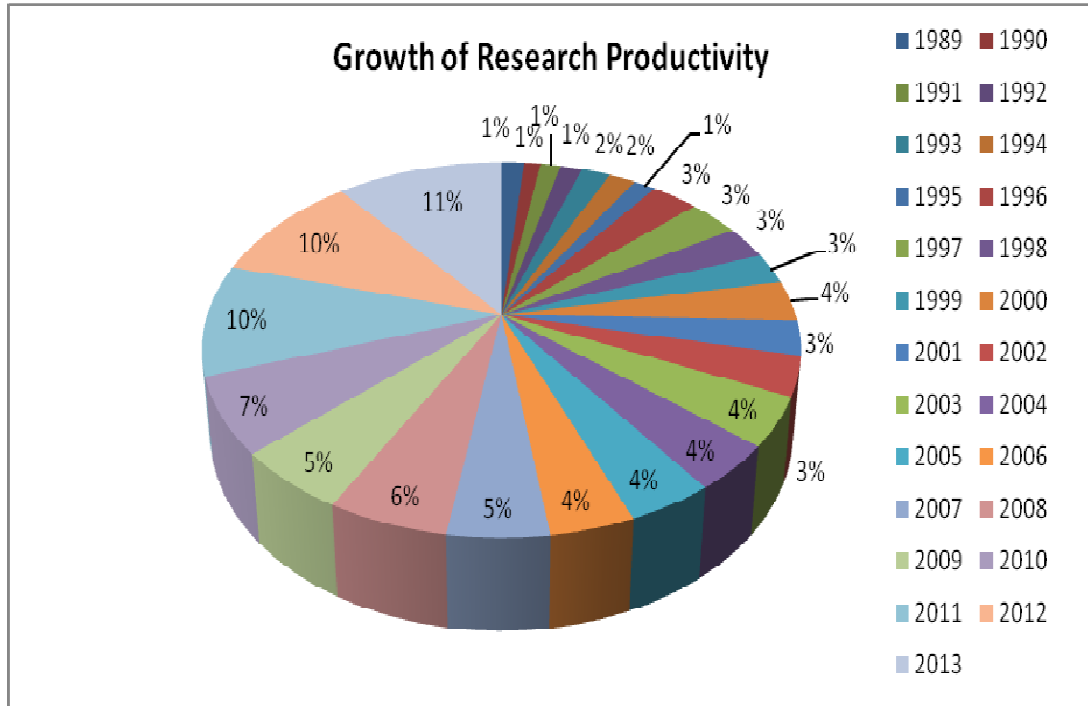
## Results and Discussion

### Growth of IGCAR research productivity

In total 5171 articles got included in *Scopus* database during 1989-2013 from Indira Gandhi Centre for Atomic Research (IGCAR). Table 1 provides growth of IGCAR research productivity in year-wise. It is seen that 66 articles are published in the year 1989 from IGCAR, which increased gradually. During 2013, more number of articles are indexed in *Scopus* i.e., 556 (10.75%), but the previous years from 1989 to 2009, has fluctuating trend, thereafter from 2009 onwards only there in an increasing trend.

**Table – 1: Growth of IGCAR Research Productivity during 1989-2013**

Sl. No	Year	Number of Papers	Per cent	Cumulative Per cent
1	1989	76	1.47	1.47
2	1990	55	1.06	2.53
3	1991	67	1.30	3.83
4	1992	73	1.41	5.24
5	1993	96	1.86	7.1
6	1994	89	1.72	8.82
7	1995	73	1.41	10.23
8	1996	155	3.00	13.23
9	1997	168	3.25	16.48
10	1998	147	2.84	19.32
11	1999	139	2.69	22.01
12	2000	181	3.50	25.51
13	2001	154	2.98	28.49
14	2002	176	3.40	31.89
15	2003	216	4.18	36.07
16	2004	203	3.93	40
17	2005	205	3.96	43.96
18	2006	200	3.87	47.83
19	2007	239	4.62	52.45
20	2008	286	5.53	57.98
21	2009	273	5.28	63.26
22	2010	338	6.54	69.8
23	2011	498	9.63	79.43
24	2012	508	9.82	89.25
25	2013	556	10.75	100.00
<b>Total</b>		<b>5171</b>	<b>100.00</b>	



**Figure 1- Growth of IGCAR Research Productivity**

Figure 1 portrays the pictographic representation of the growth of research productivity in year-wise. It is clear that at the beginning stage, the number of articles published by scientists of ‘IGCAR’ was less and increased progressively. But it can be seen that in between the ups, there is drop downs also in the number of articles.

**Relative Growth Rate (RGR) and Doubling Time (Dt)**

The relative growth rate (RGR) is the increase in number of articles/ pages per unit of time. The Mean relative growth rate (R) over the specific period of interval can be calculated from the following (Mahapatra, 1985)<sup>13</sup> equation.

**Relative Growth Rate**

$$1-2^R = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1}$$

**Doubling time (DT)**

$$\frac{0.693}{R}$$

It has been observed from the table 2 that Relative Growth Rate is in downward trend from 1990 (0.54) to 1995 (0.15). The data in table 2 reveals that doubling time has been in increased trend from 1.27 to 8.22 during 1989 - 2013. The DT has decreased once between the five year periods i.e., 1995, 2000, 2007, 2011 and 2012. It is seen from that doubling time (DT) has showed the fluctuating trend during the period of study.

**Table – 2: Relative Growth Rate (RGR) and Doubling Time (Dt)**

S. No	Year	Number of Papers	Cumulative Number of Papers	W1	W2	RGR	Doubling Time
1	1989	76	76	0	4.33	0	0
2	1990	55	131	4.33	4.88	0.54	1.27
3	1991	67	198	4.88	5.29	0.41	1.68
4	1992	73	271	5.29	5.60	0.31	2.21
5	1993	96	367	5.60	5.91	0.30	2.29
6	1994	89	456	5.91	6.12	0.22	3.19
7	1995	73	529	6.12	6.27	0.15	4.67
8	1996	155	684	6.27	6.53	0.26	2.70
9	1997	168	852	6.53	6.75	0.22	3.16
10	1998	147	999	6.75	6.91	0.16	4.35
11	1999	139	1138	6.91	7.04	0.13	5.32
12	2000	181	1319	7.04	7.18	0.15	4.70
13	2001	154	1473	7.18	7.30	0.11	6.28
14	2002	176	1649	7.30	7.41	0.11	6.14
15	2003	216	1865	7.41	7.53	0.12	5.63
16	2004	203	2068	7.53	7.63	0.10	6.71
17	2005	205	2273	7.63	7.73	0.09	7.33
18	2006	200	2473	7.73	7.81	0.08	8.22
19	2007	239	2712	7.81	7.91	0.09	7.51
20	2008	286	2998	7.91	8.01	0.10	6.91
21	2009	273	3271	8.01	8.09	0.09	7.95
22	2010	338	3609	8.09	8.19	0.10	7.05
23	2011	498	4107	8.19	8.32	0.13	5.36
24	2012	508	4615	8.32	8.44	0.12	5.94
25	2013	556	5171	8.44	8.55	0.11	6.09

#### **Form-wise Classification**

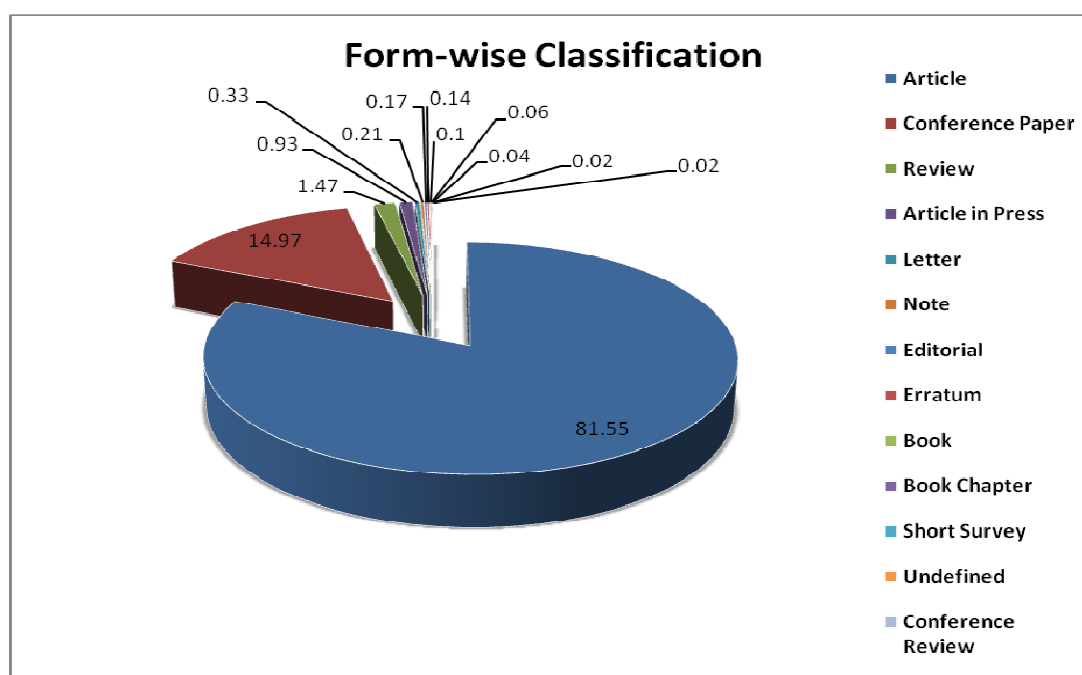
The categorization of different forms of contribution shows that 81.55 %, i.e., 4217 documents are in the form of articles which forms the majority of the



contribution. Conference paper and Review comes in second and third position with 774 (14.97%) and 76 (1.47%) contributions each. It is found that Articles in Press, Letters, Notes, Editorials, Erratums, Books, Book Chapters, Short Surveys and Conference Reviews have contributed less than one per cent of total research output.

**Table 3: Form-wise Classification of Papers during 1989-2013**

Sl. No	Type of Documents	Number of Papers	Per cent
1	Articles	4217	81.55
2	Conference Papers	774	14.97
3	Reviews	76	1.47
4	Article in Press	48	0.93
5	Letters	17	0.33
6	Notes	11	0.21
7	Editorials	9	0.17
8	Erratums	7	0.14
9	Books	5	0.10
10	Book Chapters	3	0.06
11	Short Surveys	2	0.04
12	Undefined	1	0.02
13	Conference Reviews	1	0.02
	<b>Total</b>	<b>5171</b>	<b>100.00</b>



**Figure 2- Form-wise Classification of Papers from 1989-2013**

#### **Authorship pattern**

Table 4 displays year-wise distribution of authorship pattern of IGCAR. From the Table 4, it is clear that, majority (23.38%) of the papers are four authored,

followed by three authored (18.97%), five authored papers (17.89%), two authored (11.7%), six authored (10.83%) and single authored papers (3.73%) respectively.

**Table – 4: Year-wise Authorship pattern of IGCAR during 1989-2013**

Year	1 Au	2 Au	3 Au	4 Au	5 Au	6 Au	7 Au	8 Au	9 Au	10 Au	More 10	Total
1989	8	14	22	14	11	5	0	0	1	1	0	76
1990	9	13	20	8	3	2	0	0	0	0	0	55
1991	6	15	13	19	12	2	0	0	0	0	0	67
1992	3	13	21	25	7	3	1	0	0	0	0	73
1993	6	19	32	25	9	2	1	0	0	0	2	96
1994	5	16	28	21	8	5	1	1	1	1	1	89
1995	3	14	21	19	11	1	1	0	1	0	1	73
1996	11	28	45	31	23	4	4	6	0	1	2	155
1997	9	34	41	40	18	16	4	1	3	0	2	168
1998	10	34	32	30	22	11	3	4	0	0	1	147
1999	10	21	28	39	22	9	6	3	1	0	0	139
2000	10	33	38	45	32	12	6	3	0	0	2	181
2001	5	15	36	39	32	12	9	3	2	1	0	154
2002	6	11	37	57	31	15	11	3	2	2	1	176
2003	8	30	48	56	31	18	16	3	4	2	0	216
2004	8	22	40	40	42	21	16	6	4	2	4	203
2005	11	12	39	61	39	21	10	6	1	1	4	205
2006	7	22	32	42	40	24	13	9	5	3	3	200
2007	6	15	38	42	56	35	18	14	4	3	8	239
2008	6	23	48	59	50	40	21	21	12	4	2	286
2009	12	21	42	58	46	37	26	10	10	7	4	273
2010	9	32	51	78	60	49	30	11	8	6	4	338
2011	10	41	68	119	93	71	46	26	10	8	6	498
2012	7	40	70	116	110	71	44	31	11	1	7	508
2013	8	50	91	126	117	74	38	25	11	9	7	556
<b>Total</b>	<b>193</b>	<b>588</b>	<b>981</b>	<b>1209</b>	<b>925</b>	<b>560</b>	<b>325</b>	<b>186</b>	<b>91</b>	<b>52</b>	<b>61</b>	<b>5171</b>

### Pattern of Co-Authorship

To assess the pattern of co-authorship, the following (Garg and Padhi, 1999)<sup>14</sup> formula was used:

$$CAI = \{(N_{ij} / N_{io}) / N_{oj} / N_{oo}\} \times 100$$

Where,

$N_{ij}$  = Number of papers having authors in block i

$N_{io}$  = Total output of block i

$N_{oj}$  = Number of papers having j authors for all blocks.

$N_{oo}$  = Total number of papers for all authors and all blocks

Table 5 presents the result of co-authorship index and it is observed that the value of CAI for joint authored papers is the highest and single authored papers was the lowest, which indicates that the collaborative research is increasing in IGCAR.

**Table –5: Co-Authorship Pattern**

Sl. No	Year	Single Authored	CAI	Two Authored	CAI	More than Two Authored	CAI	Total
1	1989	8	282.03	14	162.00	54	83.69	76
2	1990	9	438.43	13	207.86	33	70.67	55
3	1991	6	239.94	15	196.89	46	80.87	67
4	1992	3	110.11	13	156.61	57	91.97	73
5	1993	6	167.45	19	174.05	71	87.12	96
6	1994	5	150.52	16	158.10	67	88.67	89
7	1995	3	110.11	14	168.66	55	88.75	73
8	1996	11	190.14	28	158.86	116	88.15	155
9	1997	9	143.53	34	177.98	125	87.64	168
10	1998	10	182.26	34	203.40	103	82.53	147
11	1999	10	192.75	21	132.86	108	91.52	139
12	2000	10	148.03	33	160.34	138	89.81	181
13	2001	5	86.99	15	85.66	134	102.49	154
14	2002	6	91.34	11	54.96	159	106.41	176
15	2003	8	99.23	30	122.14	178	97.07	216
16	2004	8	105.59	22	95.31	175	101.54	203
17	2005	11	143.77	12	51.48	182	104.57	205
18	2006	7	93.77	22	96.74	171	100.71	200
19	2007	6	67.26	15	55.19	218	107.44	239
20	2008	6	56.21	23	70.72	257	105.85	286
21	2009	12	117.77	21	67.65	240	103.55	273
22	2010	9	71.34	32	83.26	297	103.50	338
23	2011	10	53.80	41	72.40	447	105.73	498
24	2012	7	36.92	40	69.25	461	106.89	508
25	2013	8	38.55	50	79.08	498	105.50	556
<b>Total</b>		<b>193</b>		<b>588</b>		<b>4390</b>		<b>5171</b>

**Degree of Author Collaboration**

The degree of collaboration among authors is the ratio of the number of papers published in a discipline during certain period of time. The mathematical

formula suggested by Subramanyam (1983)<sup>15</sup> is used for calculating degree of author's collaboration in a discipline.

$$C = \frac{Nm}{Nm + Ns}$$

Where,

C= degree of collaboration, Nm= number of multi authored papers, Ns= number of single authored papers.

The degree of collaboration in different years calculated as per the equation proposed by Subramanyam is presented in Table 6. The degree of collaboration over the years from 1989-2013 is calculated and it varies from 0.84 to 0.99. The mean value is found to be 0.95.

**Table – 6: Degree of Collaboration (DC) in publications during 1989-2013**

Year	Single Authored (NS)	Per cent	Multi Authored (NM)	Per cent	NS+NM	DC
1989	8	4.15	68	1.37	76	0.89
1990	9	4.66	46	0.92	55	0.84
1991	6	3.11	61	1.23	67	0.91
1992	3	1.55	70	1.41	73	0.96
1993	6	3.11	90	1.81	96	0.94
1994	5	2.59	83	1.67	89	0.93
1995	3	1.55	69	1.39	73	0.95
1996	11	5.70	144	2.89	155	0.93
1997	9	4.66	159	3.19	168	0.95
1998	10	5.18	137	2.75	147	0.93
1999	10	5.18	129	2.59	139	0.93
2000	10	5.18	171	3.44	181	0.94
2001	5	2.59	149	2.99	154	0.97
2002	6	3.11	170	3.42	176	0.97
2003	8	4.15	208	4.18	217	0.96
2004	8	4.15	197	3.96	202	0.98
2005	11	5.70	194	3.90	205	0.95
2006	7	3.63	193	3.88	200	0.97
2007	6	3.11	233	4.68	239	0.97
2008	6	3.11	280	5.62	286	0.98
2009	12	6.22	261	5.24	273	0.96
2010	9	4.66	329	6.61	338	0.97

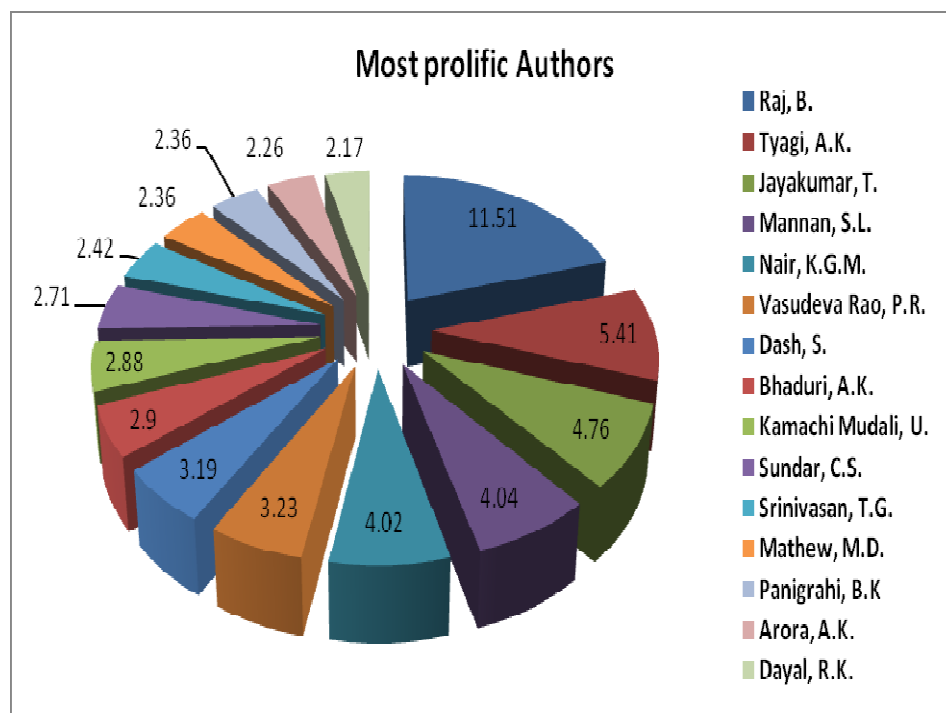
2011	10	5.18	488	9.80	498	0.98
2012	7	3.63	501	10.06	508	0.99
2013	8	4.15	548	11.01	556	0.99
<b>Total</b>	<b>193</b>		<b>4978</b>		<b>5171</b>	<b>0.95 (Mean)</b>

### Most Prolific Authors

To discover the top prolific authors were employed and equal weightage is given to each author. Average number of author per article is 3.75%. Table 7 shows the top fifteen prolific authors from IGCAR during 1989-2013. Among these authors it can be seen that the author in first position contributed the 11.51% of articles, i.e., 595 while the author who possess second position contributed only 280 articles, i.e., 5.41 and the author in the third position contributed only 246 articles, i.e., 4.76%. The author in 15th rank contributed 112 articles during the study period, i.e., 2.17 %. From the table it is apparent that B. Raj holds the first position with 595 articles, followed by A.K. Tyagi and T. Jayakumar with 280 and 246 articles respectively.

**Table - 7: Most Prolific Authors of IGCAR during 1989-2013**

Sl. No	Name of Author	Number of Papers	Per cent
1	Raj, B.	595	11.51
2	Tyagi, A.K.	280	5.41
3	Jayakumar, T.	246	4.76
4	Mannan, S.L.	209	4.04
5	Nair, K.G.M.	208	4.02
6	Vasudeva Rao, P.R.	167	3.23
7	Dash, S.	165	3.19
8	Bhaduri, A.K.	150	2.90
9	Kamachi Mudali, U.	149	2.88
10	Sundar, C.S.	140	2.71
11	Srinivasan, T.G.	125	2.42
12	Mathew, M.D.	122	2.36
13	Panigrahi, B.K	122	2.36
14	Arora, A.K.	117	2.26
15	Dayal, R.K.	112	2.17



**Figure 3- Most Prolific Authors**

#### Most Preferred Journals

Table 8 discussed the top productive journals in which the scientists of IGCAR prefer to publish their research papers. Average impact factor has been calculated from the Impact Factor (IF) obtained from Journal Citation Reports from 2000 to 2012. It is clear that, ‘*Journal of Nuclear Materials*’ is the most preferred journal and the average IF of this journal is 2.02. The second preferred journal by scientists is ‘*Transactions of the Indian Institute of Metals*’ which has the average IF as 0.43. Table 8 shows that, there are five journals published from USA and three from Netherlands. It is also seen that India and U.K published one journal each.

**Table 8: Most preferred journals by IGCAR scientists during 1989-2013**

Sl. No	Journals	Publisher	Country	No. of Articles	Average IF
1	<i>Journal of Nuclear Materials</i>	Elsevier	Netherlands	224	2.02
2	<i>Transactions of the Indian Institute of Metals</i>	Elsevier	India	162	0.43
3	<i>Aip Conference Proceedings</i>	American Institute of Physics	USA	129	-
4	<i>Nuclear Engineering and Design</i>	Elsevier	USA	111	0.98
5	<i>Journal of Radio analytical and Nuclear Chemistry</i>	Elsevier	Netherlands	105	1.42
6	<i>Materials Science and Engineering A</i>	Elsevier	USA	99	2.74
7	<i>Annals of Nuclear Energy</i>	Elsevier	USA	96	1.02

8	<i>Journal of Applied Physics</i>	American Institute of Physics	USA	85	2.19
9	<i>Journal of Alloys and Compounds</i>	Elsevier	Netherlands	74	2.28
10	<i>Materials Science and Technology</i>	Maney publishers	UK	68	2.41

### Collaboration of IGCAR Scientists

Scientific literature is being published in almost all countries in the world due to the international quality and realistic of scientific research in terms of new invention and adaptation of new technology in research. Table 9 depicts the total of 45 countries were collaborated with 915 papers during 1989-2013. It also seen that USA has highest number productive is found to be 2.86% followed by Germany (2.58%), Japan (2.23%) and Taiwan (1.14%). The some other countries such as France, United Kingdom, Italy, South Korea, Austria, Russian Federation, Netherlands, Switzerland and China collaborated less number of publications below 1%,.

**Table 9: Distribution of Collaboration of IGCAR Scientists (1989-2013)**

Sl. No	Country	No. of papers	Per cent	Rank	Sl. No	Country	No. of papers	Per cent	Rank
1	USA	173	2.86	<b>1</b>	24	Denmark	5	0.08	<b>19</b>
2	Germany	156	2.58	<b>2</b>	25	Portugal	5	0.08	<b>19</b>
3	Japan	135	2.23	<b>3</b>	26	Mexico	5	0.08	<b>19</b>
4	Taiwan	69	1.14	<b>4</b>	27	Israel	4	0.07	<b>20</b>
5	France	43	0.71	<b>5</b>	28	Puerto Rico	4	0.07	<b>20</b>
6	UK	35	0.58	<b>6</b>	29	Hong Kong	4	0.07	<b>20</b>
7	Italy	33	0.55	<b>7</b>	30	South Africa	4	0.07	<b>20</b>
8	South Korea	28	0.46	<b>8</b>	31	Spain	4	0.07	<b>20</b>
9	Austria	25	0.41	<b>9</b>	32	Bulgaria	3	0.05	<b>21</b>
10	Russia	22	0.36	<b>10</b>	33	New Zealand	3	0.05	<b>21</b>
11	Netherlands	19	0.31	<b>11</b>	34	Greece	3	0.05	<b>21</b>
12	Switzerland	15	0.25	<b>12</b>	35	Bangladesh	2	0.03	<b>22</b>
13	China	15	0.25	<b>13</b>	36	Argentina	2	0.03	<b>22</b>
14	Hungary	11	0.18	<b>13</b>	37	Finland	2	0.03	<b>22</b>
15	Canada	11	0.18	<b>14</b>	38	Ukraine	2	0.03	<b>22</b>
16	Poland	10	0.17	<b>14</b>	39	Romania	1	0.02	<b>23</b>
17	Australia	9	0.15	<b>15</b>	40	Oman	1	0.02	<b>23</b>
18	Sweden	9	0.15	<b>16</b>	41	Qatar	1	0.02	<b>23</b>
19	Singapore	8	0.13	<b>16</b>	42	Croatia	1	0.02	<b>23</b>
20	Malaysia	8	0.13	<b>17</b>	43	Indonesia	1	0.02	<b>23</b>
21	Belgium	8	0.13	<b>17</b>	44	Saudi Arabia	1	0.02	<b>23</b>
22	Czech Republic	7	0.12	<b>18</b>	45	Thailand	1	0.02	<b>23</b>
23	Brazil	7	0.12	<b>18</b>	<b>Total</b>		<b>915</b>		

### Top most collaborative institution

Table 10 revealed that top 15 institutions in most collaborative research with IGCAR, published 36 and more papers each during 1989-2013. Totally 15 institutions involved in collaborative papers with IGCAR together have contributed 21.77% share (with 1126 papers) in the cumulative publications of collaborative research with IGCAR, with an average 1.45% of papers per institution. Table 10 depicts the ranking of collaborative institutions with IGCAR; First rank is secured by *Indian Institute of Technology, Chennai* with 247 papers, second rank is secured by *Bhabha Atomic Research Centre, Mumbai* (with 160 papers), Third and Fourth rank is secured by *Anna University, Chennai* and *Indian Institute of Science, Bangalore* (with 129 and 104 papers). Rest of the institutions has contributed less than hundred papers.

**Table - 10: Top most collaborative institution of IGCAR during 1989-2013**

Sl. No	Name of the Institution	No. of Research Collaboration	Per cent	Rank
1	Indian Institute of Technology, Chennai	247	4.78	1
2	Bhabha Atomic Research Centre, Mumbai	160	3.09	2
3	Anna University, Chennai	129	2.49	3
4	Indian Institute of Science, Bangalore	104	2.01	4
5	University of Madras, Chennai	75	1.45	5
6	Raja Ramanna Centre for Advanced Technology, Indore	48	0.93	6
7	Indian Institute of Technology, Kharagpur	44	0.85	7
8	National Institute of Technology, Tiruchirappalli	44	0.85	7
9	Annamalai University, Chidambaram	43	0.83	8
10	Indian Institute of Technology, Bombay	42	0.81	9
11	Bharathiar University, Coimbatore	41	0.79	10
12	Loyola College, Chennai	40	0.77	11
13	PSG College of Technology, Coimbatore	37	0.72	12
14	Institute of Physics, Bhubaneswar	36	0.70	13
15	National Taiwan University, Taiwan	36	0.70	13

### Conclusion

The research productivity on the institutional research and development activities always shows the development of particular research field, organisation and country. The research study demonstrates the research publication trend of IGCAR scientists. This analyse found that research productivity is increased during



the study periods. Most of the scientist preferred to publish their findings in foreign journal “*Journal of Nuclear Materials*” (Netherland) with high impact factor. Though the contributions of scientists are fairly collaborative, the nature of collaboration is most of the time at local level. The research productivity of IGCAR scientist also provides some insights into the dynamic of research activity and it will enable the science policy makers and administrators to make the available adequate facilities and direct the research activities in a proper direction.

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