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A SCIENTOMETRIC ANALYSIS OF PUBLICATIONS ON ACCELERATOR-BASED RESEARCH FROM NUCLEAR SCIENCE CENTRE AND TATA INSTITUTE OF FUNDAMENTAL RESEARCH, INDIA

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ABSTRACT
The study is based on the journal publications generated by the Nuclear Science Centre (NSC) [now known as Inter University Accelerator Centre] and the Accelerator Group at the Tata Institute of Fundamental Research (TIFR) during 1997-1999. The data was collected from the annual reports of the two institutions and analyzed using scientometric tools and techniques. The impact was examined with the help of *Science Citation Index* (SCI). The analysis highlights yearly output, publication in national or international journals, number of papers in SCI-journals and non-SCI journals, normalized impact factor (NIF) per paper, category-wise distribution of papers in different NIF ranges, the proportion of high NIF papers, papers above the average NIF. NSC is a facility exclusive for accelerator research and its *Annual Report* gives clear indication of the different specializations, hence the data for NSC is further analyzed in three subdivisions of nuclear physics, materials science, and radiation biology and others. However, such an analysis for TIFR was not attempted due to the lack of such information in its *Annual Report*. From the study one can have an idea about the performance and impact of the research conducted in the two institutions.

Keywords: Scientometrics; Accelerator-based research; Inter University Accelerator Centre; Nuclear Science Centre, New Delhi; Tata Institute of Fundamental Research, Mumbai.

INTRODUCTION

Using high energy beams to study nuclear properties, characterise materials, and to examine biological systems is an important area of research in the field of physics, materials science, and biosciences. The production of such beams is possible through accelerators, and setting up such a facility is always expensive and has to be need-based.

India is fortunate enough to have two Pelletron Accelerators, one at the Nuclear Science Centre (NSC) in New Delhi and the other at the Tata Institute of Fundamental Research (TIFR) in Mumbai. The facilities conduct internationally competitive as well as comparable research as evidenced by their publications. NSC is functioning as an apex facility for researchers in the universities and colleges, spread across India, whereas TIFR is envisioned as a facility for researchers at the institutions functioning under the jurisdiction of Department of Atomic Energy (DAE). It is also interesting to note that there are collaborations between these two facilities. Other research accelerators being used in the country are not being considered for this study as we intended to restrict this study to an even area of research conducted using high energy beams produced by Pelletron Accelerators.

Analysis of recent research output started way back in 1987 at the Indian National Scientific Documentation Centre, New Delhi (INSDOC) basing the impact factor (IF) of journals provided by the *Journal Citation Reports* (JCR) of the Institute for Scientific Information (ISI), Philadelphia, PA (hereinafter referred to as JCR IF). The analysis was first carried out with the research output of the 41 laboratories of the Council of Scientific and Industrial Research (CSIR). The methodology adopted for the analysis was reported in several papers (Arora and Sen, 1991; Sen and Shailendra, 1992; Pandalai, Karanjai and Sen, 1996). It is still being used with certain modifications at National Institute of Science Communication and Information Resources (NISCAIR) for analyzing recent CSIR output.

SCOPE

The study has been conducted with the journal articles produced by the NSC, New Delhi and the Accelerator Group at the Tata Institute of Fundamental Research, Mumbai during 1997-1999. A large number of conference papers or other forms of output like chapters in monographs and editorials are excluded from the purview of this study as the JCR IF for these publications in most cases are not available. The productivity mapping of each of the researchers by considering a whole set of parameters like number of research papers published, research and consultancy projects undertaken, research theses supervised, patents and other like entities accumulated, visits to international facilities, visit by international experts, awards and rewards have not been considered.

METHODOLOGY

The methodology followed in this study is more or less analogous to the methodology of our earlier study (Jeevan and Gupta, 2001). Here, only the JCR IF has been used to assess their impact on future research in the discipline concerned. The data for this study has been gleaned from the *Annual Report* of National Science Centre for the years 1997, 1998, 1999, and 2000 (Annual Report, 1997-2000) as well as *Annual Report* of Tata Institute of Fundamental Research for the years 1997/98, 1998/99 and 1999/2000 (Annual Report, 1997-2000) and subsequently scientometric techniques were applied to generate various indicators. The *JCR* has been used to find out the impact factor of journals and *SCI* data has been utilized for quantifying the actual impact of these publications and to trace out the ongoing collaborations at different levels.

The performance has been judged on the basis of the following quantitative and qualitative parameters:

(a) Proportion of papers published in SCI journals[*];
(b) Proportion of papers published in non-SCI journals[†];
(c) Impact rate, measured in terms of normalized impact factor (NIF) per paper for papers in SCI journals;
(d) Number of papers above the average NIF and total NIF of each institution;
(e) Number of papers in the different NIF ranges and the proportion of high NIF papers, above a particular threshold, and
(f) Publication effectiveness index (PEI) as a measure of the impact of research of a particular institution in tune with the papers produced.

In addition, other factors such as the extent to which the papers are co-authored by researchers from other institutions in the country or abroad have also been taken into consideration. Among the SCI journals, the average NIF for nationally collaborative, internationally collaborative, and non-collaborative papers has been assessed. The NIF values for journals have been calculated considering the NIF of *Applied Physics Letters* as 10.

The *JCR* was consulted to identify the IF of different journals. The data for these publications have been collected from SCI database with the search for 'Institution

[*] A SCI journal is a journal which is covered by the *Science Citation Index* for generating various publications including the *Source Index*
[†] A non-SCI journal is a journal which is not covered by the *Science Citation Index*

Name' and its variations in the 'Addresses' field. The 'Accelerator Group' in TIFR is only a small research group and hence it was found that though over 300 records each year were generated by TIFR, the Accelerator Group generated only 24, 32 and 22 publications over the three year period. This has been assessed by searching for the matching publications of the Accelerator Group as well as searching for publications with at least one member of the Group as author in SCI papers.

The *Annual Report* data does not contain any information about collaborations with other institutions. However, the SCI data in the 'Addresses' field gives detail of affiliations of the authors. Two types of collaborations have been identified: (i) collaboration with one or more institutions in the country, and (ii) collaboration with institutions located outside India.

DATA ANALYSIS

Table 1 shows the year-wise distribution of papers of NSC and TIFR. The contribution of NSC in this field is more compared to the Accelerator Group of TIFR. The productivity of NSC almost doubled in 1999 compared to 1998. Why this is so is not clear.

Table 1: Year-wise List of Papers

Institution	Papers in Journals			
	1997	1998	1999	Total
NSC	52	46	90	188
Accelerator Group, TIFR	25	33	22	80

The place of publication of the journal papers is presented in Table 2 which shows that both the institutions have placed between 85 to 89% of their papers outside India. This is the usual practice with Indian scientists. They prefer to place their high quality papers in top-ranking journals of the world, which are invariably published from abroad.

Table 2: Papers published in National vs. International Journals

Institution	Papers by Country of Publication					
	India		Outside India		Total	
	#	%	#	%	#	%
NSC	28	14.9	160	85.1	188	100
Accelerator Group, TIFR	9	11.2	71	88.8	80	100

Table 3 shows the number of papers in SCI and non-SCI journals for the period from 1997 to 1999 along with their percentage. Both the institutions placed almost all their papers in SCI-covered journals which, undeniably is a good sign. Table 3 also shows that both the institutions placed very few papers in non-SCI journals. For the calculation of NIF, the IF and NIF values of non-SCI journals were considered as zero. As the number of such journals is very small, their nil values do not affect the result appreciably.

Table 3: Papers in SCI and non-SCI Journals

Institution	Papers in SCI Journals					Papers in non-SCI Journals				
	1997	1998	1999	Total	% (All)	1997	1998	1999	Total	% (All)
NSC	52	43	89	184	97.9	0	3	1	4	2.1
TIFR	24	30	22	76	95.0	1	3	0	4	5.0

Table 4 shows the average NIF values of papers as well as the average NIF value of a paper. The NIF values of NSC papers show a continuous increase and ranged from 3.077 to 4.311. The NIF values of TIFR papers are found to be higher than that of the NSC papers. This clearly indicates that TIFR placed their paper in higher impact journals compared to NSC.

Table 4: NIF per Paper

Institution	1997	1998	1999	Average
NSC	3.077	3.950	4.311	3.853
TIFR	4.945	5.690	4.830	5.221

The NIF of papers in different ranges has been summarized in Table 5. It may be seen that NSC has placed 45.2% papers in journals having NIF < 4, compared to TIFR's 31.3%. That means, NSC has placed 54.8% papers in journals having NIF > 4. The corresponding figure for TIFR is 68.7%. From the figures it is not difficult to conclude that more than two-third of TIFR's paper have been placed in higher impact journals, and 20% papers have appeared in journals with NIF >8.

Table 5: Papers in the different NIF ranges

Inst.	0.001-2.000		2.001-4.000		4.001-6.000		6.001-8.000		8.001-10.000	
	#	%	#	%	#	%	#	%	#	%
NSC	59	31.4	26	13.8	83	44.1	13	6.9	7	3.7
TIFR	17	21.3	8	10	17	21.3	22	27.5	16	20

The number of papers above the average NIF threshold is presented in Table 6. NSC has 56.4% papers above the average NIF level, and TIFR has 55% of that level. However, it is to be noted that the average NIF threshold of TIFR is considerably higher than that of NSC.

Table 6: Papers above the average NIF level

Institution	Papers above the average NIF					
	Average NIF	97	98	99	Total	%
NSC	3.853	17	21	68	106	56.4
TIFR	5.221	12	23	9	44	55.0

Accelerator-based research is pursued in a highly intra- and interdisciplinary mode the world over, and the paper attempts to identify the major specializations. Since NSC is a facility exclusive for accelerator research and its annual reports give clear indication of the different specializations, hence, the data for NSC is further categorised into the three major subdivisions of nuclear physics (NP), materials science (MS), radiation biology and others (RB) (Table 7).

However, such an analysis for TIFR, though interested, was not attempted due to the absence of such information in its *Annual Report* and for the fact that the Accelerator Group is a small group in that Institute. Furthermore, the members of this group have interdisciplinary research interests with many other research groups of the Institute, making it difficult to trail the individual research publications.

Another alternative was to compare the publications of NSC with the entire publications of TIFR, which was avoided deliberately to eliminate any bias towards TIFR that has more researchers, specializations, publications, collaborations and SCI journal papers than NSC. It may not even do justice to the point of comparison attempted in this paper, as the publications of those researchers solely depend on accelerators for their research work.

Table 7 shows NSC papers pertaining to nuclear physics, materials science, instruments, and radiation biology and others. Of the papers published materials science topped the list with a tally of 67.6% followed by nuclear physics (20.7%), instruments (6.9%), and radiation biology and others (4.8%). From the table it is quite clear that materials science is being given more emphasis compared to other subjects.

Table 8: Subject-wise Distribution of NSC Papers

	1997	1998	1999	Total	% of 188
Instruments	10	3	0	13	6.9
Materials Science	31	28	68	127	67.6
Nuclear Physics	11	12	16	39	20.7
Radiation Biology and others.	0	3	6	9	4.8
Total	52	46	90	188	100.0

Table 9 depicts subject-wise distribution of NSC papers in different NIF ranges. It may be seen that 84.6% papers on instruments were placed in journals having NIF < 2, and the rest in journals of NIF > 2 ≤ 4. No paper on this subject was placed in any high impact journals. The largest number of papers (127) were produced in materials science. Of these papers 2.4 % were placed in non-SCI journals; 40.1 % were placed in journals with NIF > 0 ≤ 4 0; and 57.5% papers found place in high impact journals having NIF > 4 ≤ 10. In all 39 papers were produced in nuclear science, of which 30.8% papers were placed in journals with NIF > 0 ≤4; one paper was placed in non-SCI journal, and the rest (66.6%) in journals with NIF > 4 ≤ 10. The number of papers on radiation biology and other was just 9. Of these 3 papers were published in non-SCI journals, 2 in journals having NIF > 0 ≤ 2, and 4 in journals with NIF > 4 ≤ 6.

Summing up we find that of the 188 papers published in these disciplines by NSC, 7 (3.7%) papers were published in non-SCI journals, 53 (28.2%) in journals with NIF > 0 ≤ 2, 25 (13.3%) in journals with NIF > 2 ≤ 4, 83 (44.1%) in journals with NIF > 4 ≤ 6, 13 (6.9%) in journals with NIF > 6 ≤ 8, and 7 (3.7%) in journals with NIF > 8 ≤ 10. In all, 103 (54.8%) papers were published in journals having NIF > 4 ≤ 10. That means majority of the papers were placed in moderately high to very high impact journals.

Table 9: Subject-wise Distribution of NSC Papers in the Different NIF Ranges

Subject.	0.001-2.000		2.001-4.000		4.001-6.000		6.001-8.000		8.001-10.00		Not available	
	#	%	#	%	#	%	#	%	#	%	#	%
Instruments	11	84.6	2	15.4	0	0	0	0	0	0	0	0
Materials Science	31	24.4	20	15.7	63	49.6	3	2.4	7	5.5	3	2.4
Nuclear Physics	9	23.1	3	7.7	16	41.0	10	25.6	0	0	1	2.6
Radiation Biology and others.	2	22.2	0	0	4	44.4	0	0	0	0	3	33.3
Total	53		25		83		13		7		7	

CONCLUSION

This paper has attempted to present a brief scientometric analysis of publications from two accelerator-based research facilities in India, the Nuclear Science Centre and Tata Institute of Fundamental Research, based on the publication data obtained from the respective annual reports, impact factor values from JCR. Both facilities have received comparable rankings on many counts, or for some attributes, one received a better ranking than the other. Out of the three specializations in NSC, material science was more productive in terms of publications whereas higher percentage of qualitative papers originated from nuclear physics. Radiation biology has a very nominal presence, may be due to the small number of researchers pursuing accelerator-based life science research in the country. The qualitative estimate of the papers based on SCI data has to be further corroborated from citation studies of each of the papers. Also a comparison of publications from other similar facilities elsewhere needs to be conducted to have a better assessment of the output in the international scene.

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