Research and citation impact of publications of the Nuclear Physics Division at Bhabha Atomic Research Centre

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ABSTRACT

The paper analyses the citations to 257 publications published during 2003-2008 by the Nuclear Physics Division at Bhabha Atomic Research Centre, using Web of Science database as the source data. The extent of citations received, in terms of the number of citations per paper, year-wise break up of citations, citation time-lag, domain-wise citations, citing authors, subject analysis of citations, categories of citing documents, citing journals, keyword analysis of citations, citing institutions, and the distribution of citations are determined. During 2003-31st August 2010, Nuclear Physics Division publications received a total of 5627 citations. The average number of citations per year was 703.38 and the average number of citations per publication was 21.89. The highest number of citations received was 1155 in 2007. Citation time-lag was zero for 76 (29.57%) papers, one year for 92 (35.80%) papers and two years for 19 (7.39%) papers. High Energy Physics and Quark Gluon Plasma domain received the highest percentage (75.5%) of citations. The core citing authors were: A. Lebedev (449) followed by D. D'Enterria (396), S. Mioduszewski (392), M.J. Tannenbaum (378), H. Masui (378), R. Averbeck (377), Y. Akiba (377), R. Lacey (375), G. David (374), T.C. Awes (374).The core journals citing Nuclear Physics Division publications were: Physical Review - C (1148 citations), Journal of Physics - G (663 citations), Nuclear Physics - A (618 citations), Physical Review Letters (347 citations), European Physical Journal - C (332 citations), Physics Letters - B (263 citations), Physical Review - D (214 citations), International Journal of Modern Physics - E (169 citations), European Physical Journal - A (121 citations).

Keywords: Citation analysis; Scientometrics; Bibliometrics; Research productivity; Research evaluation

INTRODUCTION

Evaluation is a very important component of any research and development activity in a research institution. Evaluating science has become a major aim for those dealing with decision making for the management of science. Martin and Irvin (1983) have thoroughly reviewed the basic research inputs and outputs and various possible assessment methods. They also considered the count of scientific publications and citations, and peer evaluation methods providing characteristic indicators. Publication and citation counting techniques have been used in the assessment of scientific activity for at least fifty years (Narin 1976). Laharia and Singh (1987) have discussed the various approaches used to measure the

scientific productivity and Lancaster (1991) has suggested bibliometric measures of productivity and impact in research.

Citation brings out the connection between two documents; the one which cites and the other which is cited. The act of citing in general, an expression of the importance of the material cited, as authors often refer to previous material to support, illustrate or elaborate on a particular point (Garfield 1978; 1994). A highly cited work, naturally, is the one that has been found to be useful by relatively large number of authors, or in relatively large number of experiments. Citation count is, therefore, a measure of scientific activity, utility and impact of scientific work. However, citation counts do not say anything about the nature, utility or impact of the work (Garfield 1979a).

Citation analysis constitutes an important tool in qualitative and quantitative studies of science and technology. To assess the quality of a given publication, the number of times it has been cited in the literature can be counted. Similarly, the number of times a person has been cited in the literature can be taken as a measure of the quality of that person's work (Garfield 1979b; Lawani 1977; Moravcsik, Murugesan and Shearer 1976; Narin, Carpenter and Woolf 1983; Smith 1981; Wallmark and Sedig 1986). Citation analysis is a more complex task than is often recognised in the sense that it requires careful identification of exactly what is being analysed. Every citation represents a decision of the author to draw attention to the work of another as being relevant to his theme at a particular point in the document he is writing (Sandison 1989). Citation counts help a research administrator to assess the quality of, not only each individual scientist, but also that of his organisation as a whole. A few studies of this sort on individual institutions / departments have been conducted all over the world (Salisbury 1980; Cohen 1981; Schubert and Braun 1981; Yankevich 1982; Carpenter et al. 1988; Garg and Rao 1988; Vinkler 1990; Kalyane and Kalyane 1991; Minor and Dostatni 1991; Dizon and Sadorra 1995; Ugolini, Parodi and Santi 1997; King 1998; Gupta, Suresh Kumar and Khanna 1999; Zacho 1991; Frohlich and Resler, 2001; Koganurmath, Angadi and Kademani 2002; Lee 2003; Schloegl et al. 2003). Kademani et al. (2005a; 2005b; 2006, 2007a) have carried out scientometric analysis to understand publication productivity of various divisions of Bhabha Atomic Research Centre such as Bio-organic Division, Chemistry Division, Analytical Chemistry Division, and Radiochemistry Division. Adopting similar method, Girap et. al. (2009) have also carried out the analysis for publication productivity of Technical Physics and Prototype Engineering Divisions of Bhabha Atomic Research Centre. Kademani et. al. (2007b) have studied the impact of 1733 publications published during 1970–1999 by the Chemistry Division of Bhabha Atomic Research Centre, by analysing the citations received to the publications using Science Citation Index for the period 1982–2003.

The unit of study in citation analysis can be any form of written communication or an author, an organisation or a nation (Small and Greenlee 1979). However, citation counts cannot be taken as the sole measure of quality, because numerous other factors affect scientists' work and the impact of their publications is only a measure of their overall influence. For instance, a scientist who spends most of his time on teaching may contribute in an indirect way to the future achievements of his institution. Sometimes a scientist may require years of background work to prepare a paper and that single paper itself would be a vital contribution having more value than that of publications of other prolific authors. Nevertheless, scientists themselves are almost invariably keen to see this kind of information (Martyn 1975; Cronin 1984; Mac Roberts and Mac Roberts 1989; Brown 1993; Mahajan 1993). One should be very careful while collecting and carrying out citation analysis as it may contain some discrepancies (Garfield 1977; Moed and Vriens 1989) and

that citation analysis as a subject remains controversial (Taube 1993). Liu (1993) reviewed on the citation studies that have dealt with citation functions, citation quality, citation concept and citation motivation. Rousseau (1995) proposed a framework within which citations can be used for evaluation purposes.

Nuclear Physics Division (NPD) is one of the important divisions of Bhabha Atomic Research Centre established in the early stages of Department of Atomic Energy to carry out research and developmental activities relevant to atomic energy programmes. It carries out basic research in low, intermediate and high energy nuclear physics and accelerator based applied research. It also looks after operation, maintenance and development of ion accelerators and development of instrumentation for Nuclear Physics Research. Upadhye et al. (2010) have carried out the publication productivity of the Nuclear Physics Division of Bhabha Atomic Research Centre for the period 2003 - 2008. The present study attempts to carry out citation analysis of NPD publications published during 2003-2008 reported in Chatterjee, Suresh Kumar and Choudhury (2008).

OBJECTIVES, MATERIALS AND METHODS

The main objective of the study is to highlight the citation impact of publications by the Nuclear Physics Division (NPD) at Bhabha Atomic Research Centre (BARC), specifically to highlight the following:

a) the extent of citations received to the publications of NPD at BARC;
b) year-wise growth of citations to NPD publications;
c) domain-wise distribution of citations;
d) the time-lag between publication of a paper and its getting first citation;
e) core authors citing NPD publications;
f) subject category-wise analysis of journal citations;
g) types of documents citing NPD publications;
h) the scattering of citations among journals;
i) the institutions citing NPD publications;
j) the country-wise distribution of publications citing NPD publications; and
k) the keywords of citing documents to assess the influence of NPD publications on other areas of research

NPD of BARC has published a total of 257 publications during 2003-2008. The present citation analysis covered the period from 2003 to August 2010. All the 257 publications published during 2003-2008 were considered for the analysis. Citations were collected for each publication from the *Web of Science.* All the data elements were transferred to a spreadsheet application and after data validation, scientometrics analysis was carried out as per objectives of the study.

RESULTS AND DISCUSSION

The 257 papers sampled in this study are categorised in various domains: High Energy Physics and Quark Gluon Plasma, Nuclear Reactions and Spectroscopy, Intermediate Energy Reactions, Theoretical Research, Nuclear Fission, Interdisciplinary Research and Applications, Detectors and Nuclear Instrumentation, and Accelerators and Instrumentation. During 2003-31st August 2010 these 257 publications have received a total of 5627 citations. The average number of citations per year was 703.38. The average

number of citations per publication was 21.89. Table 1 details the distribution of NPD publications on the basis of citations received.

Table 1: Distribution of Citations Received for NPD's Publication Output

Number of citations	Number of publications	Total number of citations	Cumulative	Number of citations	Number of publications	Total number of citations	Cumulative
0	50	0	0	36	1	36	1489
1	29	29	29	37	1	37	1526
2	30	60	89	38	1	38	1564
3	13	39	128	39	1	39	1603
4	14	56	184	41	1	41	1644
5	5	25	209	42	2	84	1728
6	4	24	233	44	1	44	1772
7	10	70	303	46	1	46	1818
8	11	88	391	47	1	47	1865
9	3	27	418	48	2	96	1961
10	4	40	458	50	1	50	2011
11	4	44	502	51	1	51	2062
12	5	60	562	59	1	59	2121
13	2	26	588	60	1	60	2181
14	2	28	616	62	2	124	2305
15	3	45	661	64	1	64	2369
16	3	48	709	67	1	67	2436
17	1	17	726	77	2	154	2590
18	2	36	762	84	1	84	2674
20	2	40	802	85	1	85	2759
21	3	63	865	101	1	101	2860
22	1	22	887	120	1	120	2980
23	2	46	933	122	1	122	3102
24	1	24	957	125	1	125	3227
25	4	100	1057	134	1	134	3361
26	1	26	1083	157	1	157	3518
27	3	81	1164	179	1	179	3697
28	1	28	1192	263	1	263	3960
30	2	60	1252	306	1	306	4266
31	1	31	1283	316	1	316	4582
32	1	32	1315	334	1	334	4916
34	2	68	1383	711	1	711	5627
35	2	70	1453	**Total**	**257**	**5627**	-

Year-wise Growth of Citations

Figure 1 presents year-wise growth of citations of NPD publications. The continuous growth of citations was found throughout except in the year 2008 and 2010. The citation rate peaked during 2006-2009 as the maximum 4055 (72.36%) citations were received during the period. The highest numbers of citations received were 1155 in the year 2007. Citations received in 2009 and 2010 are exclusively of the publications published during 2003-2008, since 2009 and 2010 publications are not included in this study. It is interesting to note that NPD publications continue to garner citations.

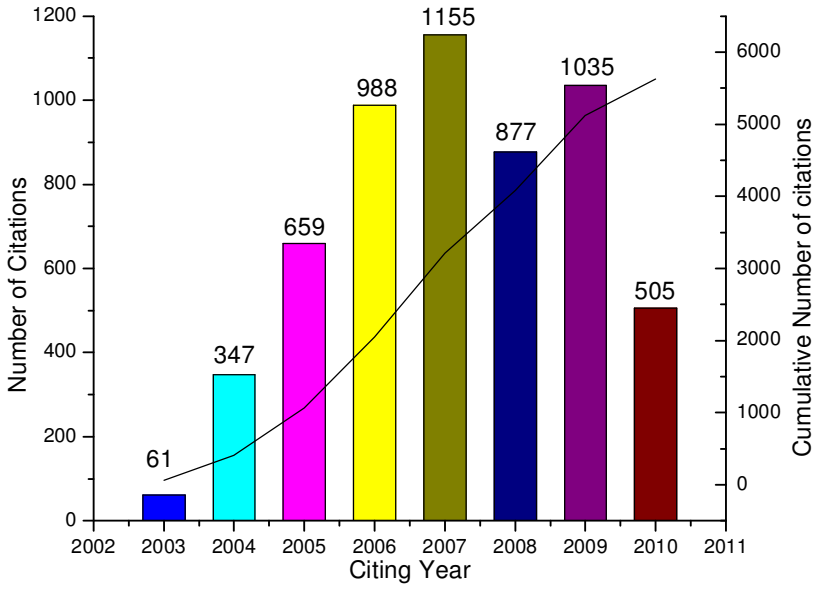

Figure 1: Year-wise Growth of Citations Received by NPD Publications

Domain-wise Distribution of Citations

Table 2 shows the number of publications and the citations received in each domain of NPD research areas. NPD has contributed significantly to eight main domains: High Energy Physics and Quark Gluon Plasma with 58 publications, Nuclear Reactions and Spectroscopy (78), Intermediate Energy Reactions (27), Theoretical Research (23), Nuclear Fission (22), Interdisciplinary Research and Applications (29), Detectors and Nuclear Instrumentation (14), and Accelerators and Instrumentation (6) during 2003-2008.

Table 2: Domain-wise Publications of NPD and the Citations Received

Domain	No. of Publications	No. of citations	% of Citations	Cumulative % Citations
High Energy Physics and Quark Gluon Plasma	58	4248	75.5	75.5
Nuclear Reactions and Spectroscopy	78	677	12.0	87.5
Intermediate Energy Reactions	27	272	4.8	92.3
Theoretical Research	23	170	3.0	95.3
Nuclear Fission	22	128	2.3	97.6
Interdisciplinary Research and Applications	29	78	1.4	99.0
Detectors and Nuclear Instrumentation	14	48	0.9	99.9
Accelerators and Instrumentation	6	6	0.1	100.0
Total	**257**	**5627**	-	-

In terms of citations garnered, 'High Energy Physics and Quark Gluon Plasma' has received 4248 (75.5%) citations followed by, 'Nuclear Reactions and Spectroscopy' with 677 (12%) citations , 'Intermediate Energy Reactions' (272, 4.8%), 'Theoretical Research' (170, 3%), 'Nuclear Fission' (128, 2.3%), 'Interdisciplinary Research and Applications' (78, 1.4%), 'Detectors and Nuclear Instrumentation' (48, 0.9%) citations, and 'Accelerators and Instrumentation' with 6 (0.1%) citations. The citation rate depends on a variety of factors such as the number of people working, number of papers published, type of publications, and the area of research (highly specialised or broad).

Year-wise citations received by NPD for their publications in various domains are presented in Figures 2a - 2h. It was observed that citations peaked in 2009 for the domains Nuclear Reactions and spectroscopy, Nuclear Fission, Theoretical Research, Detectors and Nuclear Instrumentation, and Accelerators and Instrumentation while citations peaked during 2007-2008 for the domain Intermediate Energy, High Energy Physics and Quark Gluon Plasma in 2007 and Interdisciplinary Research Applications in 2008.

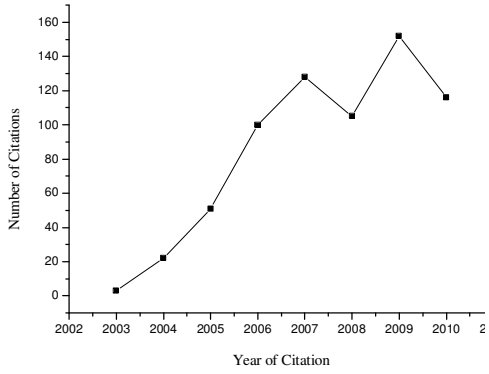

Figure 2a: Year-wise Growth of Citations in Nuclear Reactions and Spectroscopy

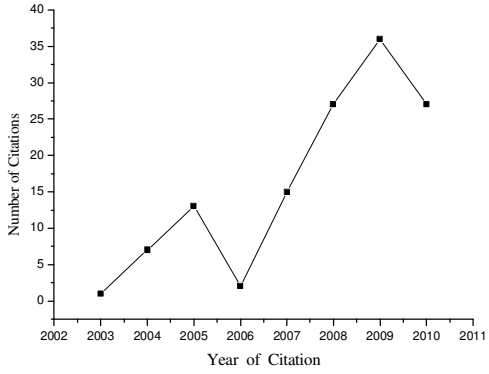

Figure 2b: Year-wise Growth of Citations in Nuclear Fission

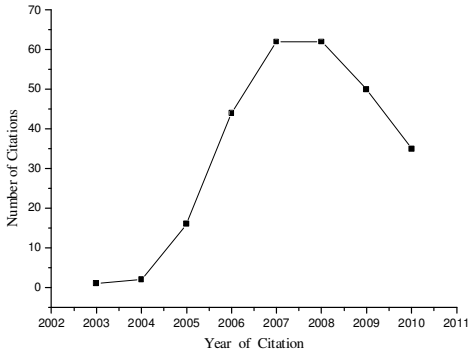

Figure 2c: Year-wise Growth of Citations in Intermediate Energy Reactions

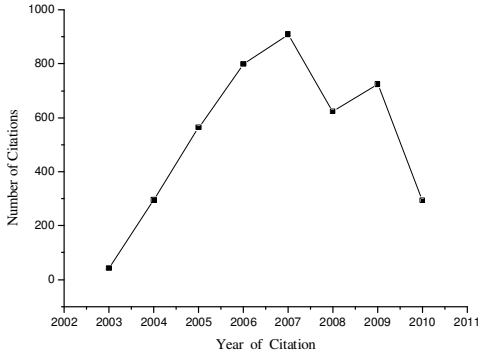

Figure 2d: Year-wise Growth of Citations in High Energy Physics and Quark Gluon Plasma

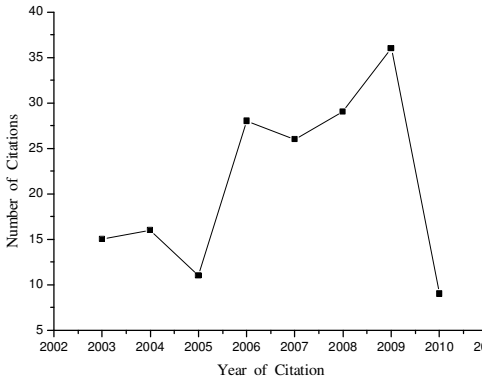

Figure 2e: Year-wise Growth of Citations in Theoretical Research

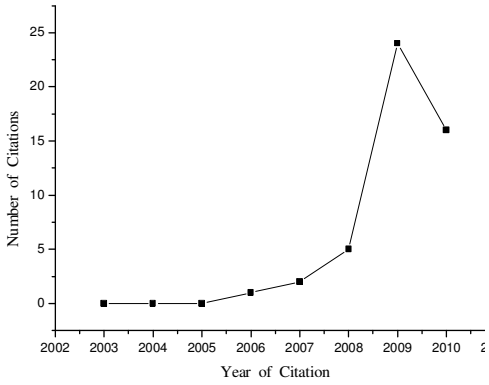

Figure 2f: Year-wise Growth of Citations in Detectors and Nuclear Instrumentation

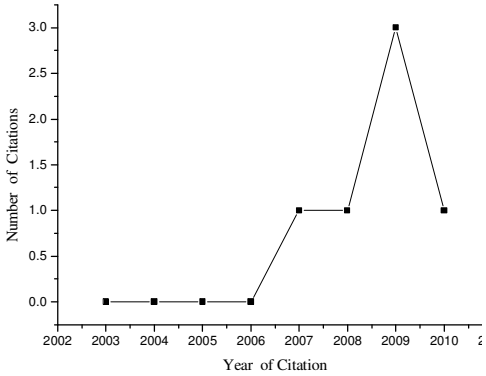

Figure 2g: Year-wise Growth of Citations in Accelerators and Instrumentation

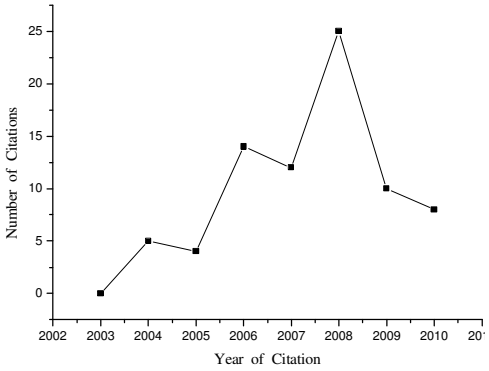

Figure 2h: Year-wise Growth of Citations in Interdisciplinary Research and Applications

Citation Time-Lag

Citation time-lag is one of the indicators which may throw light on independence of research programmes or individual scientists. The average value of time-lag within a particular citing publications or series of publications reflects how modern the publication is or how integrated it is in the evolving research front. In rapidly evolving 'hot' areas, time-lag will be small and in many cases zero. If time-lag is large, say ten years, it usually indicates that the publication or series of publications belongs to a stagnating research area or is out of contact with main stream of research.

For calculating the time-lag, 257 publications published during 2003-2008 have been considered. Out of 257 publications, 50 (19.46%) publications remain un-cited. Hence only 207 publications were considered for calculating the time-lag. Time-lag between publications of an article and its receiving first citation in the case of NPD publications is in the range of 0 to 5 years. It was revealed that 76 (29.57 %) publications received citations in the same year of publication, followed by 92 (35.80 %) publications received citations after one year of publication, 19 (7.39 %) publications received citations after two years of publication, 14 (5.45 %) publications received citations after three years of publication, 5

(1.95 %) publications received citations after four years of publication, and 1 (0.39 %) publication received citations after five years of publication. It is found that 65.37 percent of the publications have received their first citations within two years of their publication indicates that NPD publications were noticed instantly and had immediate direct impact among the fellow researchers working all over the world in the field of nuclear physics. This also indicates that domain related to these cited publications are rapidly evolving "hot'' areas. Figure 3 depicts the number of publications and the citation time-lag.

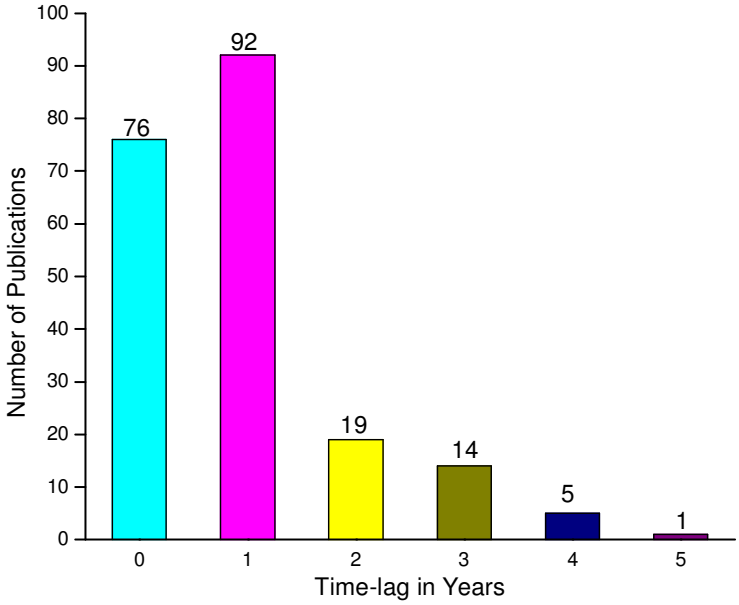

Figure 3: Citation Time-lag for NPD Publications

Subject Category-wise Analysis of Journal Citations

All the citing journals of NPD were classified as per the Web of Science subject categories. Table 3 shows that the distribution of journal citations of NPD was not only from nuclear physics category but also cover many multidisciplinary areas of research. This indicates the influence and impact of NPD publications over many allied areas of research.

Extent of Citations and Categories of Citing Documents

In order to gain visibility, it is important to know what is published and what communication channel is chosen for publication. A high quality paper published in an internationally well-known journal attracts the attention of the scientists instantly and receives many citations whereas an important paper published in an unknown journal may remain dormant and uncited for years. Table 4 indicates the types of documents citing NPD publications. Among the citations received, 4696 (83.45%) were from journal articles, followed by 476 (8.46%) conference papers, 431 (7.66%) reviews, 8 (0.14%) corrections, 8 (0.14%) letters, 4 (0.07%) chapters in books, 3 (0.05 %) editorials and 1 (0.02%) reprint.

Table 3: Distribution of Citing Journals and Citations of Nuclear Physics Division Publications as per Web of Science Subject Categories

Sl. No.	Subject Category	Number of Journals	No. of Citations
1	Nuclear Physics	10	2924
2	Physics - Multidisciplinary	43	1215
3	Particles and Fields Physics	8	740
4	Nuclear Science and Technology	9	87
5	Mathematical Physics	4	66
6	Atomic Physics and Molecular Chemistry	8	40
7	Astronomy and Astrophysics	5	15
8	Fluids and Plasma Physics	1	11
9	Multidisciplinary Science	4	8
10	Chemical Engineering	3	4
11	Geochemistry and Geophysics	2	4
12	Condensed Matter Physics	4	4
13	Polymer Science	1	4
14	Chemistry - Multidisciplinary	2	3
15	Physical Chemistry	3	3
16	Materials Science Composites - Multidisciplinary	3	3
17	Biochemistry and Molecular Biology	1	2
18	Analytical Chemistry	2	2
19	Computer Science - Interdisciplinary	1	2
20	Engineering - Multidisciplinary	1	2
21	Materials Science Ceramics	2	2
22	Optics	2	2
23	Chemistry Inorganic and Nuclear	1	1
24	Energy and Fuels	1	1
25	Materials Science Coatings and Films	1	1
26	Applied Physics	1	1
		123	5147

Table 4: Types of Documents Citing NPD Publications

Types of Documents	Number of Citations	Citations %	Cumulative Citations %
Journal articles	4696	83.45	83.45
Conference Papers	476	8.46	91.91
Reviews	431	7.66	99.57
Corrections	8	0.14	99.72
Letters	8	0.14	99.86
Chapters in Books	4	0.07	99.93
Editorial Materials	3	0.05	99.98
Reprint	1	0.02	100.00
Total	5627	100.00	-

Citing Journals and their Distribution

This section discusses the journals that are citing NPD publications and the quality of the citing documents. Basically, one of the important factors by which the quality of a journal is ascertained, is by its impact factor. Analysis indicates that, out of 5087 journal citations, 5022 (98.72%) citations were from 119 international journals, and only 65 (1.28%) citations were from four Indian journals. Table 5 presents the journal-wise scattering of citations along with their impact factor. The leading citing journals were: *Physical Review- C* with 1148 citations, *Journal of Physics - G* (663 citations), *Nuclear Physics - A* (618 citations), *Physical Review Letters* (347 citations), *European Physical Journal - C* (332 citations), *Physics Letters - B* (263 citations) and *Physical Review - D* with 214 citations. It is observed that most of the NPD publications are cited in prestigious journals having high impact factor.

Table 5: Journals Citing NPD Publications Receiving ≥ 10 Citations

Sl. No.	Citing Journals	IF 2009	Number of Citations	% of Citations
1	Physical Review - C	3.477	1148	22.57
2	Journal of Physics - G	2.124	663	13.03
3	Nuclear Physics - A	1.706	618	12.15
4	Physical Review Letters	7.328	347	6.82
5	European Physical Journal - C	2.746	332	6.53
6	Physics Letters - B	5.083	263	5.17
7	Physical Review - D	4.922	214	4.21
8	International Journal of Modern Physics - E	0.643	169	3.32
9	European Physical Journal - A	1.968	121	2.38
10	Acta Physica Polonica - B	0.648	89	1.75
11	International Journal of Modern Physics - A	0.941	80	1.57
12	Journal of High Energy Physics	6.019	63	1.24
13	Physics of Atomic Nuclei	0.539	63	1.24
14	Pramana-Journal of Physics	0.349	60	1.18
15	Chinese Physics - C	0.251	49	0.96
16	Modern Physics Letters - A	1.075	44	0.86
17	Acta Physica Hungarica - A	-	40	0.79
18	Nuclear Instruments & Methods in Physics Research Section - A	1.317	38	0.75
19	Journal of Physics A - Mathematical and General	-	33	0.65
20	Czechoslovak Journal of Physics	-	31	0.61
21	Annual Review of Nuclear and Particle Science	-	29	0.57
22	Chinese Physics Letters	0.972	28	0.55
23	Progress of Theoretical Physics Supplement	0.547	28	0.55
24	Brazilian Journal of Physics	0.575	27	0.53
25	Nuclear Physics - B	-.	27	0.53
26	Reports on Progress in Physics	11.444	26	0.51
27	European Physical Journal-Special Topics	0.84	25	0.49
28	Journal of Physics A-Mathematical and Theoretical	1.577	23	0.45
29	Progress of Theoretical Physics	2.368	22	0.43
30	High Energy Physics and Nuclear Physics - Chinese Edition	0.233	20	0.39
31	Physics Letters - A	2.009	18	0.35
32	Physics Reports - Review Section of Physics Letters	17.752	18	0.35
33	Nuclear Instruments & Methods in Physics Research Section - B	1.156	17	0.33
34	Rivista Del Nuovo Cimento	3.5	17	0.33
35	Physics of Particles and Nuclei	0.935	13	0.26
36	Journal of the Korean Physical Society	-	12	0.24
37	Nuclear Data Sheets	1.145	12	0.24
38	Communications in Theoretical Physics	0.579	11	0.22
39	Nuclear Physics B	4.341	11	0.22
40	Physical Review E	2.4	11	0.22
41	Physical Review A	2.866	10	0.2

Top Institutions Citing Nuclear Physics Division Publications

In all, there were 1093 institutions which have appeared in the citing papers. Table 6 gives the core citing institutions based on their frequency of appearance in the citing papers. Top ten citing institutions were Brookhaven National Laboratory, USA with 1377 citations, SUNY Stony Brook, USA (932 citations), Joint Institute of Nuclear Research, Dubna, Russia (622 citations), Columbia University, USA (507 citations), University of Sao Paulo, Brazil (482 citations), University of Tokyo, Japan (474 citations), Bhabha Atomic Research Centre, Mumbai, (467 citations), CE Saclay, Gif Sur Yvette, France (443 citations), Los Alamos National Laboratory, USA (439 citations) and Oak Ridge National Laboratory, USA with 427 citations.

Publications from Top Countries Citing Nuclear Physics Division Publications

All the countries which have appeared in the affiliation field in the citing papers were counted. In all, there were 71 countries citing NPD publications. The most frequently occurred countries in the citing papers were: USA with 2783 citations followed by Germany with 1106 citations, India (944 citations), Peoples Republic of China (891 citations), France (848 citations), Russia (774 citations), Japan (770 citations) and Brazil with 540 citations. Figure 4 shows the top citing countries having citations greater than or equal to 400 citations.

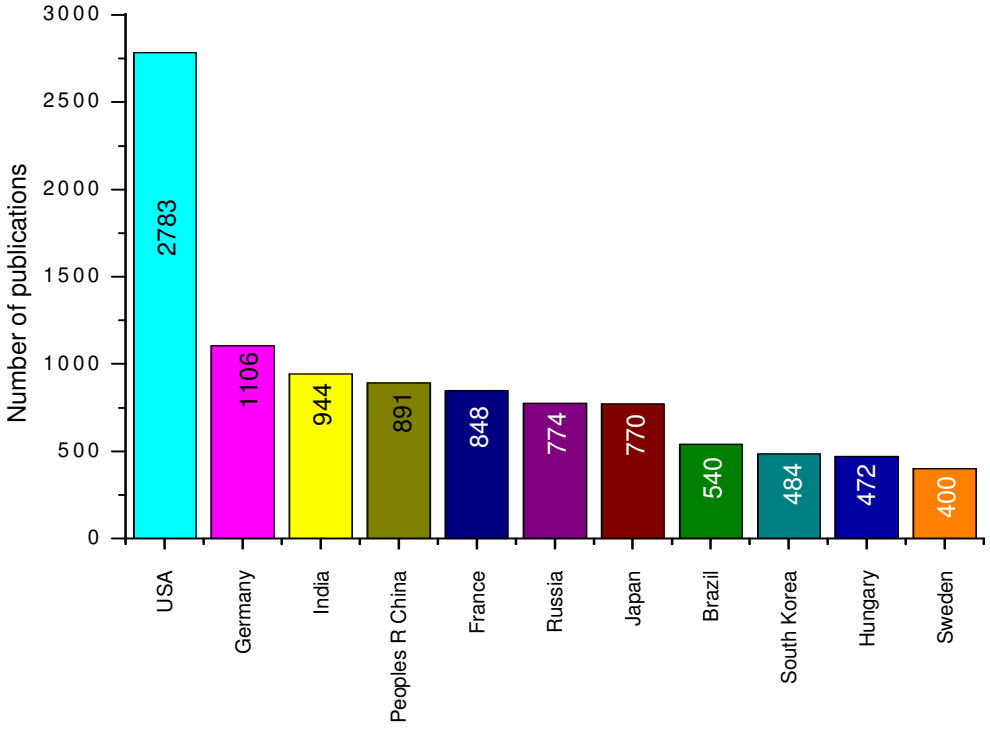

Figure 4: Top Countries citing Nuclear Physics Division publications

Table 6: Core Institutions Citing NPD Publications

Rank	Citing Institutions	No. of citations	%
1	Brookhaven Natl. Lab., USA	1377	3.67
2	SUNY Stony Brook, USA	932	2.49
3	Joint Inst. Nucl. Res., Dubna, Russia	622	1.66
4	Columbia Univ., USA	507	1.35
5	Univ. Sao Paulo, Brazil	482	1.29
6	Univ. Tokyo, Japan	474	1.26
7	Bhabha Atomic Research Centre, Mumbai, India	467	1.25
8	CE Saclay, Gif Sur Yvette, France	443	1.18
9	Los Alamos Natl. Lab., USA	439	1.17
10	Oak Ridge Natl. Lab., USA	427	1.14
11	Kyoto Univ., Japan	418	1.12
12	Petersburg Nucl. Phys. Inst., Russia	413	1.1
13	Univ. Paris, Paris, France	412	1.1
14	Univ. Tsukuba, Japan	412	1.1
15	Univ. Nantes, Nantes, France	407	1.09
16	Iowa State Univ., USA	406	1.08
17	Lawrence Livermore Natl. Lab., USA	391	1.04
18	Univ. Tennessee, USA	386	1.03
19	Vanderbilt Univ., USA	386	1.03
20	Florida State Univ., USA	384	1.02
21	Russian Res. Ctr., Kurchatov Inst., Moscow, Russia	377	1.01
22	Tokyo Inst. Technol., Japan	376	1
23	Univ. Illinois, USA	374	1
24	Univ. Munster, Munster, Germany	370	0.99
25	Univ. Calif. Riverside, USA	368	0.98
26	Weizmann Inst. Sci., Israel	367	0.98
27	Korea Univ., South Korea	366	0.98
28	Ecole Polytech, France	365	0.97
29	Yonsei Univ., South Korea	363	0.97
30	Lund Univ., Dept. Phys., SLund, Sweden	358	0.96
31	KEK, Ibaraki, Japan	358	0.96
32	Seoul Natl. Univ., South Korea	357	0.95
33	RIKEN, Inst. Phys. & Chem. Res., Wako, Saitama, Japan	357	0.95
34	Hiroshima Univ., Higashihiroshima, Japan	356	0.95
35	Univ. New Mexico, USA	355	0.95
36	Texas A&M Univ., USA	353	0.94
37	Univ. Clermont Ferrand, Clermont Ferrand, France	353	0.94
38	Waseda Univ., Japan	349	0.93
39	Banaras Hindu Univ., India	346	0.92
40	New Mexico State Univ, USA	344	0.92
41	Debrecen Univ., Hungary	342	0.91
42	Abilene Christian Univ., USA	341	0.91
43	Georgia State Univ., USA	340	0.91
44	Nagasaki Inst. Appl. Sci., Nagasaki, Japan	340	0.91
45	Nevis Labs., USA	340	0.91
46	China Inst. Atom Energy, Peoples R China	334	0.89
47	Myongii Univ., South Korea	315	0.84
48	St. Petersburg State Polytech Univ, Russia	314	0.84
49	Univ. Colorado, USA	300	0.8
50	Inst High Energy Phys., Protvino, Russia	300	0.8

Distribution of Keywords in the Citing Publications

Keywords are one of the best scientometrics indicators to understand and grasp instantaneously the thought content of the papers and to find out the growth of the subject field. Analysing the keywords appeared either in the title or assigned by the indexer or the author himself will help in knowing in which direction the knowledge grows. The high frequency keywords will enable us to understand the aspects of Nuclear Physics that have been studied. The keywords appeared in the "Keywords" and "Keywords Plus" fields in Web of Science of citing papers were analysed to assess the impact of the NPD publications to the wide ranging domains of Nuclear Physics. The high frequency keywords were Quark-Gluon Plasma (1166), Heavy-Ion Collisions (987), Collisions (762), Nucleus-Nucleus Collisions (711), QCD (644), Matter (569), Elliptic Flow (532). Table 7 gives a list of high frequency keywords appeared ≥ 50 times.

Table 7: Keywords Appearing ≥ 50 Times in Citing Publications

Keywords	Frequency
QUARK-GLUON PLASMA	1166
HEAVY-ION COLLISIONS	987
COLLISIONS	762
NUCLEUS-NUCLEUS COLLISIONS	711
QCD	644
MATTER	569
ELLIPTIC FLOW	532
TRANSVERSE-MOMENTUM	325
SCATTERING	291
COLOR GLASS CONDENSATE	271
ENERGY-LOSS	252
NUCLEAR COLLISIONS	244
RADIATIVE ENERGY-LOSS	230
GLUON PLASMA	205
ENERGY	191
PB-PB COLLISIONS	188
SPS	186
HADRON-PRODUCTION	177
AU+AU COLLISIONS	174
NUCLEI	173
PLUS AU COLLISIONS	172
SPECTRA	172
LARGE TRANSVERSE-MOMENTUM	169
PARTON DISTRIBUTIONS	168
PHENIX	167
ROOT-S	156
FINITE-TEMPERATURE	149
CENTRALITY DEPENDENCE	135
HADRON SPECTRA	135
DEEP-INELASTIC SCATTERING	130
PHASE-TRANSITION	122
AU COLLISIONS	121
PROTON	121
DETECTOR	120
ENERGIES	119
STAR	119
CHARGED-PARTICLE	116
GLUON DISTRIBUTION	116
J / PSI SUPPRESSION	109

Keywords	Frequency
JETS	85
PION INTERFEROMETRY	85
THERMODYNAMICS	79
NUCLEAR-MATTER	78
D+AU	76
EMISSION	75
COULOMB BARRIER	74
NUCLEUS COLLISIONS	74
MULTIPLICITY	72
DRELL-YAN	70
FLUCTUATIONS	69
OPACITY	69
PHOTOPRODUCTION	68
TEMPERATURE	68
PROTON-PROTON	67
ION COLLISIONS	66
RELATIVISTIC NUCLEAR COLLISIONS	66
FUSION	65
FINAL-STATE INTERACTIONS	63
BOSE-EINSTEIN CORRELATIONS	62
DECAY	61
PARTON ENERGY-LOSS	61
ABELIAN ENERGY-LOSS	60
PROMPT PHOTON PRODUCTION	60
PARTONS	59
TOMOGRAPHY	59
VECTOR-MESONS	59
CHIRAL-SYMMETRY	57
ANISOTROPIC FLOW	56
HYDRODYNAMICS	56
ANISOTROPY	55
COLLECTIVE FLOW	55
E+E-ANNIHILATION	55
EQUILIBRATION	55
FREEZE-OUT	55
SMALL X	55
SYMMETRY	55
TRANSITION	54
AU-AU COLLISIONS	53

HADRONS	105
TO-LEADING ORDER	105
SIGNATURE	104
FRAGMENTATION FUNCTIONS	100
ELASTIC-SCATTERING	96
HIGH-DENSITY QCD	96
QUARK	96
MESON	92
RESONANCE	92
PARTICLES	86
PLASMA	86

LEADING ORDER	53
PHOTONS	53
PSEUDO-HERMITICITY	53
NON-HERMITIAN HAMILTONIANS	52
PARTON	52
FIELD-THEORY	51
INELASTIC ALPHA-SCATTERING	51
LHC	51
TRANSPORT	51
INTERFEROMETRY	50
PARTICLE-PRODUCTION	50

CONCLUSION

This paper has attempted to highlight the impact of research carried out by the scientists of NPD at BARC during 2003-2008. The Division has published 257 publications during this period in diverse domains. The citation analysis of these publications is carried out covering the period 2003-31st August 2010 using Web of Science. During this period, NPD has received a total of 5627 citations. The results indicate that 80.16 percent of the cited papers have received their first citations within five years of their publication indicating that NPD publications were noticed immediately by the researchers working all over the world in this field and well integrated in the evolving research front. The highest number of citations received were 1155 in 2007. The average number of citations per year was 703.38 and the average number of citations per publication was 21.89. As many as twelve highly cited publications could be identified based on the number of citations they have received. High Energy Physics and Quark Gluon Plasma domain received the highest percentage (75.5%) of citations. NPD publications received the highest number of citations from the United States of America with 2783 citations, followed by Germany with 1106 citations and India with 944 citations. Brookhaven National Laboratory, U.S.A. cited 1377 times the NPD publications followed by SUNY Stony Brook, U.S.A. with 932 citations and Joint Institute of Nuclear Research, Dubna, Russia with 622 citations. It will be quite interesting, if one attempts to study the motivations, for which Nuclear Physics Division publications received citations.

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