

# Doctoral Theses in Physics Submitted to University of North Bengal: A Pattern of Citation Analysis

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**Abstract** – The study is based on 8,182 citations appended to 50 doctoral theses in Physics, submitted to the North Bengal University, Darjeeling, during 1987 to 2007, with an average number per thesis comes at a range of 163.64. The study of the citations is carried out with a view to ascertaining what types of documents are the most frequently used in the research process. The study indicates authorship trend was towards team works rather than a work in isolation. Single author contributions, even though shown a decreasing tendency, are still on stage. Chronological variation in the various characteristics of the cited literature was also examined. It is observed that most of the publications cited are articles in journals; the number of references to other kinds of documents such as books/monographs, patents, conference proceedings, reports, and other theses is small; and references like official publications, press articles and Internet documents are rare. Among the citations from journal literature, majority are from foreign journals though the journals of Indian origin have also extensively used by the North Bengal University Physics researchers. Journals published in USA, India, Netherland and UK occupies premier positions while journals from other countries are also cited. The most frequently cited journal titles were the *The Physics Letter*, *Physics Review A*, *Mol. Cryst. Liq. Crystal*. The findings from this study could serve as a collection development, a model that libraries could use to identify the primary sources, budget planning, to guide collection maintenance and user services design in libraries.

**Keywords:** Citation Analysis, Physics, Productivity of Guides, Authorship Collaboration, Authorship Pattern, Core Journals

## I. INTRODUCTION

Citation analysis is a worthwhile area of research. "Citation analysis" refers to references in one text to another text, with information on where that text can be found. Citation analysis is useful for understanding subject relationships, author effectiveness, publication trends, and so on. The first recorded citation analysis was Gross and Gross (1927) who looked at citation patterns to determine the journals to be

subscribed to and back volumes to be acquired for the library of Pomona College. They studied the citation frequency in the references given in the *Journal of the American Chemical Society* (Amudhavalli 1997). With citation analysis one can evaluate and interpret citations received by articles, authors, institutions, and other indications of scientific activity (Ravichandra Rao 1993).

Diadoto (1994) defines citation analysis as "a wide ranging area of bibliometrics that studies the citations to and from documents. Such studies may focus on the documents themselves or on such matters as: their authors; the journals (if the documents are journal articles) in which the articles appear". Strohl's (1999) definition of citation checking is also on point for the current study: "a sample of citations from textbook bibliographies, journal articles, student dissertations or other sources are checked against holdings to see what proportion is owned."

Citation analysis is also a way to understand users. Studying references cited by your faculty's publications or your students' papers shows you the types of sources most commonly used and valued locally in their disciplines (Curtis 2005). It makes use of bibliographic references, which are an essential part of scientific communication (*Encyclopedia of Library and Information Science*, 1998). Citation analysis is a major area of bibliometric research, which uses various methods of citation analysis to establish relationships between authors or their work (Ane's *Encyclopedic Dictionary of Library and Information Science*, 2006).

Theses/Dissertations clearly indicate the needs of doctoral students, and also indicate the research specialties of the faculty and departments as a whole. With exceptions for new (or defunct) programs, current and historic data is readily available in an institution's dissertations, though significant processing is required. The present study is undertaken to analyze the characteristics of literature used by researchers in

the field of physics. The present study will help the scientists and librarians in the selection of core journals and other sources in physics.

**II. OBJECTIVES**

The investigation aims at establishing the following objectives

1. To study the year-wise break up of theses in various discipline of sciences submitted to North Bengal University during 1987-2007;
2. To study the guide ship pattern in physics;
3. To study the productivity of guides in the selected discipline;
4. An analysis of the recorded citations to determine the average number of citations in physics;
5. To study the rate of collaborative research by analyzing the authorship pattern of the citations;
6. To study the pattern of contributing authors in physics;
7. To determine the use of different types of documents like books, periodicals, journals articles, conference proceedings, reports, online, etc.
8. To observe the chronological distribution of citations to determine the productive years of used publications;
9. To study the country wise distribution of cited journals to find out the country of origin of the published journals;
10. To compile a rank list of core journals in physics.

**III. METHODOLOGY**

The research design adopted was a descriptive study. The 50 doctoral theses which are the products of research activity have been examined for the present study. 50 doctoral theses accepted in between 1987-2007, by North Bengal University in physics from the sample for the study. Bibliographic details (names of authors, supervisors, the category of the item, publication details, age of the item as on the year of the thesis etc) of all the references appended to the 50 theses were collected in a predefined data sheet i.e., Microsoft Access. The total number of citations appended to these documents is 8,182. Necessary information has been recorded, analyzed and tabulated for making observations.

**IV. DATA ANALYSIS AND DISCUSSION**

Table I shows the year wise break up of theses in physics submitted to the respective department of North Bengal University from 1987-2007. In all of total 50 theses have

TABLE I YEAR WISE BREAK UP OF THESES IN PHYSICS

SI. No.	Year	No of Theses
1	2007	1
2	2006	2
3	2005	2
4	2004	0
5	2003	1
6	2002	5
7	2001	0
8	2000	3
9	1999	3
10	1998	2
11	1997	2
12	1996	2
13	1995	4
14	1994	0
15	1993	5
16	1992	0
17	1991	4
18	1990	6
19	1989	2
20	1988	2
21	1987	4
	Total	50

been submitted in the selected subject. Year-wise analysis of theses reveals that the maximum contribution was made during 1990, with 6 theses followed by the year 1993, 2002 (five numbers). It is interesting to note that not even a single Ph.D was awarded in 2004, 2001, 1994 and 1992.

TABLE II GUIDESHIP PATTERN IN PHYSICS

Number of Guides	No.of Theses	Percent
1	47	94.0
2	3	6.0
Total	50	100

The Table shows the Guideship pattern in Physics. The table reveals that 94% scholars have a Single guide while 6% scholars have a double guide.

TABLE III PRODUCTIVITY OF GUIDES

Sl. No.	Name of Guide	No of Theses	Rank
1	N Chaudhuri	10	1
2	S Acharyya	7	2
3	Pradip Kumar Mandal	4	3
4	S Mukherjee	4	3
5	Shukla Paul	4	3
6	D Das Gupta	4	4
7	Ranjit Paul	3	4
8	Biswanath Bhattacharyya	2	5
9	M M Banerjee	2	5
10	N Kar	2	5
11	S K Ghosal	2	5
12	S N Sen	2	5
13	B Banerjee	2	5
14	Paritosh Biswas	1	6
15	P Ghosh	1	6
16	Krishna Pranab Chanda	1	6
17	B Das	1	6
18	Malay Kumar Das	1	6

TABLE IV AVERAGE NO. OF CITATIONS

No. of theses	Total citations	Average
50	8182	163.64

TABLE V FORM DISPERSION OF CITATIONS

Sl. No.	Forms of Document cited	No. of citation	Percentage	Cumulative no. of citation	Cumulative percentage	Rank
1	Journal Articles	6690	81.76	6690	81.76	1
2	Books/Monograph	682	8.34	7372	90.1	2
3	Seminar/ Conference paper	277	3.39	7649	93.49	3
4	PhD thesis & Dissertation	208	2.54	7857	96.03	4
5	Reports	152	1.86	8009	97.89	5
6	Others : includes manual, URLs, Lecture notes, Unpublished etc.	173	2.11	8182	100	6
	Total	8182	100	8182		

TABLE VI AUTHORSHIP PATTERN OF JOURNAL CITATIONS

Sl. No.	No. of Authors	No. of Citations	Percentage
1	One	1846	22.56
2	Two	2880	35.21
3	Three	1762	21.53
4	Four	1117	13.65
5	Five	237	2.90
6	More than five	340	4.15
	Total	8182	100

Dr. N Chaudhuri, has guided highest number of PhDs in physics, with 10, followed by Dr. S Acharyya, who has guided 7 scholars. The third place is occupied by Dr. Pradip Kumar Mandal, Dr. S Mukherjee, D Das Gupta and Dr. Shula Paul respectively who have guided 4 scholars in each and so on.

The table represents the average number of citations per theses in physics. In total of 8182 citations were analyzed out of 50 theses with around 163.64 average citations.

The citations were classified into various bibliographic forms such as Journals, Books, Conference Proceedings, Ph.D Dissertations, and Reports etc.

Table V represent the form dispersion in physics. The total number of citations in the discipline is 8182. It is evident from the analysis that a large portion of the documents used include Journal articles 6690 (81.76%) Monographs/ Books 682 (8.31%), Seminar/ Conference paper 277 (3.39%), Ph. D theses/ Dissertations 208 (2.54%), Reports 152 (1.86%), and others 173 (2.11%).

Journal articles are the most important form of publication cited, followed by books, Seminar/ Conferences paper, Ph.D theses/ Dissertations and Reports.

The authorship pattern reflects the nature of productivity of writers associated with Physics discipline. Whether

the preference is of solo works or collaborative works are appreciated. The trend of authorship pattern can be gauged by analyzing the author dispersion relating to works of single authors and multiple authors.

Table VI presents the authorship pattern in the field of physics. Two authored papers comprised the highest percentage (35.21%) of total 8182 papers/ citations. Single authored papers constituted 22.56% of the cited papers. Three authored papers accounted for 21.53%, four authored papers counted for 13.65%, five authored counted for 2.90% and the rest i.e., 4.15% were by six or more authors. Thus, multi-authored papers far outnumbered single- authored papers, accounting for 77.44% of the total cited papers.

This clearly indicates that the predominance of multi-authored papers (77.44%) over single-authored papers (24.35%). The ratio between single and multi-authored papers is approximately 1:3. The high incidence of multiple authorship is a characteristic of the science.

**V. DEGREE OF AUTHOR COLLABORATION**

The extent of collaboration in research can be measured with the help of multi - authored papers. To determine the degree of collaboration in quantitative terms, the formula given by Subramanayam has been used. The formula is as

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

Where C= Degree of Collaboration in a discipline

Nm = Number of Multi authored papers

Ns = Number of single authored papers

TABLE VII

Author	Publications	Percentage
Single	1846	22.56
Multiple	6336	77.44

$$C = \frac{6336}{6336+1846} = 0.774$$

The degree of collaboration is 0.776 as a whole. This clearly indicates the trend towards collaborative research. This reflects the degree of prevalence of multiple authored publications in physics, which reflects higher level of collaboration. This supports the observation of Price (1963) that team research is a common trend in scientific activity.

**VI. CHRONOLOGICAL ANALYSIS/ TIME DISPERSION**

TABLE VIII CHRONOLOGICAL DISTRIBUTION OF CITATION

Sl. No.	Year	No. of citation	Percentage	Cumulative frequency
1	2000-2007	376	2.60	4.60
2	1990-1999	1501	18.34	22.94
3	1980-1989	2695	33.93	55.88
4	1970-1979	2462	31.09	85.95
5	1960-1969	665	8.13	94.08
6	1950-1959	265	3.24	97.32
7	Before 1950s	218	2.67	99.99
	Total	8182	100	

Table VI examines the time dispersion of citations in physics. A total number of citations were analyzed for determining the age of utility of the publications were 8182. The study covers the time span under the year blocks in decades. The analysis reveals that the years 1980-1989 (32.94%) is the most productive decade followed by 1970-1979 (30.09%) is at second position, the years 1990-1999 (18.34%), the years 1960-1969 (8.13%), the years 2000-2007 (4.59%) and before 1950s with (2.67%).

Research work cover published literature from any part of the world. The relevance and importance of the maximum used material can be related to the country producing the largest usable literature. The citation study of the research dissertations can lead to understand the country wise use pattern of researchers in physics.

TABLE IX (JOURNALS HAVING 30 OR MORE THAN 30 CITATION EACH)

Sl. No.	Country	No. of Journals	No of Citations	Percentage	Rank
1	USA	20	1905	28.48	1
2	India	17	964	14.40	2
3	Netherlands	5	791	11.82	3
4	UK	7	426	6.37	4
5	Denmark	2	198	2.96	5
6	Japan	2	73	1.09	6
7	France	1	75	1.12	7
8	Italy	1	69	1.04	8
9	Germany	1	65	0.98	9
10	Canada	1	40	0.59	10
11	Others	337	2084	31.15	11
	Total	395	6690	100	

The Journals are analyzed according to their country of origin and the result of the most productive countries is shown in the Table IX. It has been observed from the analysis that India is the leading country with 28.48% of the total journals cited. USA has a contribution with 20.21 % of journals and UK with 7.50%. It can be inferred from the analysis that,

India, USA and UK are the prominent countries of Physics journals that have been cited by the research scholars of the respective departments.

### VII. RANKED LIST OF CORE JOURNALS

Journals are very useful for researchers for the scientific communication but their increasing cost puts the librarian to study the quality, usefulness and suitability to a particular

group of users. Core journals ranking studies are usually made to help in the selection of journals and in assessing the importance of one or more journals in a particular subject field. Frequency of citations or use of journal is governed by many factors such as availability, language and country of publication, size and frequency of publication, coverage in secondary journals, reprint dissemination, reputation of the authors and so on. Therefore, the present study is to judge the variable and productive journals, cited in Physics.

TABLE X RANKED LIST OF CITED JOURNALS IN PHYSICS

Sl. No.	Journals	No of Citations	%	Accum. Citations (%)	Rank
1	Physics Letter	409	6.12	6.12	1
2	Physical Review. A	309	4.62	10.75	2
3	Mol. Cryst.Liq. Crystal	201	2.86	13.6	3
4	Physical Rev. Letter	178	2.67	16.27	4
5	Indian Journal of Pure and Applied Physics	157	2.35	18.62	5
6	Journal of Applied Physics	153	2.29	20.91	6
7	Physics Review. B	143	2.14	23.05	7
8	Astrophysical Journal	134	2.10	25.15	8
9	Acta Crystallogr.	119	1.78	26.93	9
10	Journal of Chemical Physics	118	1.76	28.69	10
11	Journal of Crystal Growth	113	1.69	30.38	11
12	Liq. Cryst.	107	1.60	31.98	12
13	Current Science	103	1.55	33.53	13
14	Journal of Non Crystal Solids	97	1.46	34.99	14
15	Physics C	89	1.34	36.33	15
16	Nature	88	1.33	37.66	16
17	J. Sound and Vibration	83	1.25	38.91	17
18	Sound and Vibration	81	1.22	40.13	18
19	Int. J. Non-Liner Math.Physics	79	1.19	41.32	19
20	Indian Journal of Pure and Applied Math	77	1.15	42.47	20
21	Astronomy and Astrophysics	75	1.13	43.6	21
22	Appl. Phys. Letter	74	1.10	44.7	22
23	J. Fluid Mech	72	1.07	45.77	23
24	Z. Phys.	69	1.03	46.8	24
25	Bulletin of Material Sciences	69	1.03	47.83	24
26	Z. Naturforsch	65	0.97	48.8	25
27	Proceedings of the Indian academy of Science	65	0.97	49.77	25
28	Physics	63	0.94	50.71	26
29	Physics News	62	0.93	51.64	27
30	Pramana ( A Journal of Physics)	58	0.87	52.51	28
31	Journal of Astrophysics and Astronomy	56	0.84	53.35	29
32	Physics Today	55	0.82	54.17	30
33	Science	53	0.79	54.96	31
34	Physics Fluids -A	51	0.74	55.7	32
35	Indian Journal of Physics	49	0.64	56.34	33

36	Physics Fluids – B	47	0.71	57.05	34
37	Solid State Science	47	0.71	57.76	34
38	Proceedings of the IEEE	45	0.67	58.43	35
39	Advances in Physics	43	0.64	59.07	36
40	Bulletin of the Astronomical Society of India	42	0.63	59.7	37
41	Journal of the physical society of Japan	41	0.61	60.31	38
42	Asian Journal physics	41	0.61	60.92	38
43	Canadian Journal of Physics	40	0.59	61.51	39
44	Rev. Mod. Physics	39	0.58	62.09	40
45	Journal of Fluids and Structure	39	0.58	62.67	40
46	Bulletin Calcutta mathematical Society	39	0.58	63.25	40
47	Indian Journal of Physics-B	38	0.57	63.82	41
48	Bulletin of Astronomical Society of India	37	0.55	64.37	42
49	Physical Review –C	35	0.52	64.89	43
50	Journal of Aeronautical Society of India	34	0.51	65.4	44
51	Indian Journal of Chemistry	34	0.51	65.91	44
52	Reviews of Modern Physics	33	0.50	66.41	45
53	Annals of mathematical physics	33	0.50	66.91	45
54	Journal of the society of material Science	32	0.49	67.4	46
55	Journal of Indian Chemical Society	32	0.49	67.89	46
56	Transactions of the American Nuclear Society	31	0.48	68.37	47
57	MNRS	30	0.47	68.84	48
58	Other less than 30 citations	2084	31.16	100	49
	Total	6690	100		

In the collected data all the 6690 articles have been published in 395 journals which have been ranked up to 48 positions. These are journals in which the frequency of occurrence is 409 to 30. The journals with less than 30 articles have not been considered. The calculation was made with the application of Bradford Law; which resulted that in the first zone 13 journals contained 2244 articles, in the second zone 40 journals contained 2237 articles and remaining 342 journals contained 2209 articles in the third zone.

In other words, we can say that first 13 journals have covered 1/3 of the total articles, next 40 journals have covered 1/3 articles and 342 journals also covered yet another 1/3 articles. Thus the first 13 journals are regarded as core journals in the field.

The ranked list of most productive journals as appeared in the source theses is presented in table VIII. It is clearly evident from analysis that The Physics Letter tops the list with highest contribution of 409 (6.12%) citations.

Physics Review A, is in the second position by accounting 309 (4.62%) citations. While Mol. Cryst.Liq. Crystal occupies the third position with 201 (2.86%) citations and so on. It is important to note that Indian Journal of Pure and Applied Physics occupies fifth position with 157 (2.34%) of citations.

It is interesting to note that high status of multi-disciplinary journals like Nature and Science etc. are also in the ranked list of physics journals literature.

### VIII. FINDINGS AND CONCLUSION

The present study is an approach to the analysis of information used by the University scientific community on the basis of the Ph.D theses defended in the Department of Physics at the North Bengal University from 1987 to 2007 to trace the development of scientific research. The results provided useful insight into the information base of University scientific production in this respective discipline. A total of 50 Ph.D theses in Physics were read in those years which contain 8,182 bibliographic references, with an average number per thesis comes at a range of 163.64.

Authorship is an important facet of scientific research. A detailed analysis of the authorship of Citations reveals that research is, now a day a team works rather than a work in isolation. Therefore in a large majority of scientific publications in physics find more than one names in the author statement. Collaborative authorship is often considered to be indicative of authenticity of the contents of the document. Scientists choose to engage in collaboration for a variety of reasons, such as access to equipment, finance, expert guidance and information support. The study reveals that team research is on the increase in physics. Single author contributions, even though shows a decreasing tendency, and is still on stage. This may be due to the fact that the scientists undertake research projects which do not require team work.

According to the distribution by document type most of the publications cited are articles in journals; the number of references to other kinds of documents such as books, conference proceedings, and other theses is small; and references like official publications, press articles and Internet documents are rare. The high percentage of citations of journal articles confirms the important role played by scientific journals in the process of Scientific Communication. The paucity of citations of other types of documents such as monographs, theses, Internet papers and reference tools like encyclopedia, subject dictionaries etc. may be both due to the difficulty in accessing such literature and to the fact that as these sources are least concern in science research.

The journals are the most intensely cited by Ph.D thesis authors which reflect the use of information contained primarily in periodicals. This appears to be due to the fact that in this disciplines, periodical literature tends to be the most current and up-to-date and the information is accessible through a variety of channels. As a result, scholars are very interested in reviewing periodical material and the libraries

have stressed the need to develop those collections in the respective disciplines.

The preference of learned foreign journals as the major medium of science communication is a well established fact. Most probably the lack of indigenous literature on local problems may be the reason that prompts the scholars to depend more on foreign sources for their background study of the topic. But the present study revealed that the papers from periodical of Indian origin have greatly used by the North Bengal University physics researchers. The high preference towards Indian publications leads to the conclusion that either these learned journals are readily available or the researchers are very much inclined to Indian publications. Researchers in physics at North Bengal University paid less attention to the bulk of the literature available in foreign sources, may be due to unavailability of the international publications, limited budgets or else. The chronological distribution of the cited items reveals that publications of before 1950s are still continue to be cited in the theses on sciences. The availability of age old basic documents in sciences which have considerable relevance even in the modern era is evident from the citation practice in theses.

In designing a collection development strategy for the North Bengal University library, care should be taken to make sure that the top most frequently cited journals in each discipline are readily available in order to introduce students at an early stage in their research to the outstanding publications in the field. While this study and its findings are specific to North Bengal University, the citation analysis methodology that was employed would be applicable in other settings as well, for it provides a model that libraries could use to identify the primary sources used in research. In addition, the results from a study of this type may be used in budget planning so that limited funds are used effectively and disciplines requiring more periodicals in foreign publications, receive additional allocations. Since the doctoral theses had been accepted in the normal academic order, their references would meet at least the minimal requirements of scientific quality. There observed a lack of standard for arranging the references in the Ph.D dissertations selected for this study. In order to have a better visibility of the cited works a uniform standard is expected to be adopted. The concern authority may adopt a standard of its own or the Indian Standard for this purpose may be adopted.

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