

## CITATION ANALYSIS OF PH.D. THESES SUBMITTED TO KARNATAK UNIVERSITY, DHARWAD IN THE FIELD OF PHYSICS

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In this paper an attempt has been made to identify the attributes of subject literature in Physics as reflected in theses submitted to Karnatak University, Dharwad during 1992-2006. The study is based on the 10, 057 citations given in the references in the 37 theses. Subject wise distribution, form wise distribution, authorship pattern, chronological distribution of journals and books, half-life period of journals are also examined. Journal of *Chemical Physics* ranked first among 548 journals. It is found from the study that Half-life period of journals is 33 years.

**KEYWORDS:** Physics; Theses; Karnatak University; Citation Analysis

### 1 INTRODUCTION

Effective access to information is an essential requirement for the success of any information systems and for researchers/scholars, journal are the most dependable sources of information (Aina and Mabawonku, 1997). Although journals form the major part of the literature consulted by researchers/scholars, rising cost of journals and the increasing number of journals are making it more difficult for libraries to provide researchers with all the information they need. Citation analysis is a useful tool for evaluating the use of library collections.

Citation analysis is the examination of the frequency, patterns and graphs of citations in articles and books (Garfield, 1983 and Rubin, 2004). Citation analysis is one of the well-known methods used in a university library environment. Not only do citations play an important part in the scholarly communication process, but 'citations and the composition of bibliographies reflect changes in the information seeking behaviour of academics', as well (Naude and Du Toit, 2005). In this regards, theses and dissertations have proved to be particularly appealing to use for assessing library collections because they serve as a convenient source of in-house research. Furthermore, Zipp (1996) found that 'the most heavily cited

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journal titles in theses and dissertations can be used as a surrogate for the titles most heavily used by faculty in their publications'. This is because the research interests of graduate students often reflect the research interests of the faculty advisers.

## 2 OBJECTIVES OF THE STUDY

The main objective of the present study is to identify the attributes of subject literature in Physics as reflected in theses references. Specific objectives were:

1. To examine subject wise break up of research in physics;
2. To study the distribution of citations in different bibliographic forms;
3. To know the authorship pattern of cited articles;
4. To analyse chronological distribution of journal and book citations;
5. To analyse half-life period of journals in Physics;
6. To establish a list of core journals in the field of physics; and
7. To analyse Bradford's Law of Scattering to the data under study.

## 3 METHODOLOGY

The literature cited in the Ph.D. theses in the field of Physics was the principal base of information relating to the sources used by the researchers. In the context of the main objective this study examined the citation patterns of researchers in Physics using the references appended to Ph.D. theses submitted to the Karnataka University, Dharwad, India, during 1992-2006. A total of 37 Ph.D. theses with 10,057 citations were recorded giving an average of 272 (0.027 %) citations per thesis. The data was tabulated in terms of subject-wise distribution of journals and books, ranked list of journals etc. Further, half-life period of journal citations was calculated using graphs and Bradford's Law of Scattering was applied to the cited journals.

## 4 RESULTS AND DISCUSSION

### 4.1 Subject-wise Distribution

Fig. 1 shows the subject wise break up of theses. The study revealed that out of the total 37 theses, i.e. 14 (37.84%) theses were on Spectroscopy, followed by 10 theses (27.03%) on Nuclear Physics, 8 theses (21.62%) on Solid State Physics and 5 theses (13.51%) on Electronics.

## Citation Analysis of Ph.D. Theses

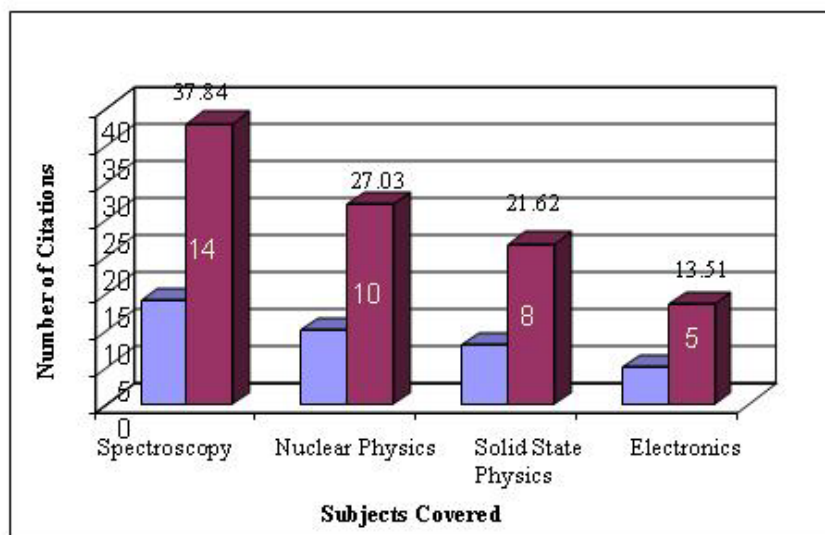


Fig. 1: Subject-wise break up of Ph.D. theses

### 4.2 Form-wise Distribution of Citations

Table 1 presents data on the form-wise distribution of citations. S my expected journals were the most cited form accounting for 8,100 (80.54%) citations of the total (10,057) citations; citations from books were 1101(10.95%), followed by conference proceedings with 319 (3.17%) citations, theses with 153 (1.52%) citations,, these forms together accounted for 9673 (96.18%) of all the citations. All other forms taken together accounted for 384 citations (about 3.8%).

Table 1: Bibliographic form-wise distribution of citations

Sl. No.	Bibliographic Form	Total Number of Citations	Percentage
1.	Journals	8100	80.54
2.	Books	1101	10.95
3.	Proceedings	319	3.17
4.	Theses	153	1.52
5.	Technical Publications	70	0.70
6.	Reports	64	0.64
7.	Handbooks	31	0.31
8.	Notes	13	0.13
9.	Patents	07	0.07
10.	Manuals	06	0.06
11.	Reviews	02	0.02
12.	Monographs	01	0.01

Sl. No.	Bibliographic Form	Total Number of Citations	Percentage
13.	Standards	01	0.01
14.	Personal Communication	01	0.01
15.	News Papers	01	0.01
16.	Un identified	187	1.86
<b>Total</b>		<b>10, 057</b>	<b>100</b>

### 4.3 Authorship Pattern

Authorship pattern of cited references is graphically represented in Fig. 2. Authorship pattern of citations indicates that the highest and lowest number of citations were by two-authors and ten-authors respectively. The number of citations with two authors is 3,469 (34.5%), followed by single-authored papers 3030 (about 30 %) citations and three-authored papers 2091 (about 20.7%) citations. About 70% of the citations are of joint authorship.

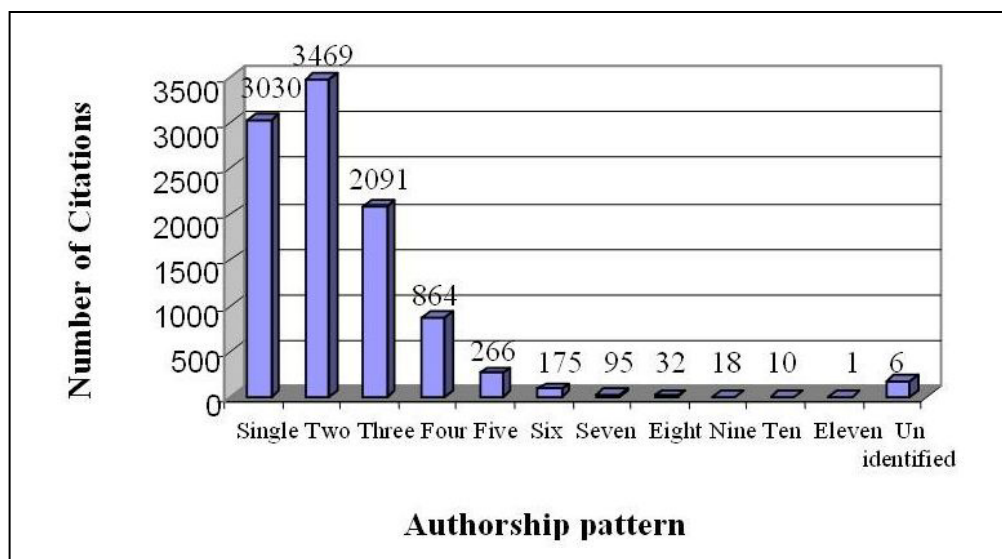


Fig. 2: Authorship Pattern

### 4.4 Chronological Distribution of Journal Citations

Table 2 presents data on the chronological distribution of journal citations. The maximum number of journal citations are dated from 1980 to 1989 (with 2095 citations 25.86%). The number of unidentified citations, that is, without indication of the year of publication was 70 (0.86%). The periods 1860-1869 and 1870-

## Citation Analysis of Ph.D. Theses

1879 recorded only one citation each. This indicates that researchers used mostly recent publications.

**Table 2: Chronological Distribution of Journal Citations**

<b>Period of Citations</b>	<b>No. of Citations</b>	<b>Percentage</b>
1850-59	03	0.04
1860-69	01	0.01
1870-79	01	0.01
1880-89	03	0.04
1890-99	06	0.07
1900-09	18	0.22
1910-19	46	0.57
1920-29	41	0.51
1930-39	185	2.28
1940-49	360	4.44
1950-59	875	10.80
1960-69	1259	15.54
1970-79	1621	20.01
1980-89	2095	25.86
1990-99	1255	15.49
2000-06	261	3.22
Un identified	70	0.86
<b>Total</b>	<b>8100</b>	<b>100.00</b>

### 4.5 Chronical Distribution of Book Citations

Table 3 presents data on the chronological distribution of book citations. The maximum number of book citations belonged to the period 1960-1969 with 321(29.15%) citations. The unidentified citations were 09 (0.82%) citations. The least number of book citations were of the period 1900-1909 with 2 citations.

**Table 3: Chronological Distributions of Book Citations**

<b>Period of Citations</b>	<b>No. of Citations</b>	<b>Percentage</b>
1850-59	---	---
1860-69	---	---
1870-79	---	---
1880-89	03	0.27
1890-99	---	---
1900-09	02	0.18
1910-19	---	---
1920-29	16	1.45
1930-39	06	0.54
1940-49	70	6.36

Period of Citations	No. of Citations	Percentage
1950-59	136	12.35
1960-69	321	29.15
1970-79	294	26.70
1980-89	170	15.44
1990-99	67	6.08
2000-06	07	0.63
Un identified	09	0.82
<b>Total</b>	<b>1101</b>	<b>100.00</b>

#### 4.6 Ranked List of Cited Journals

Table 4 gives a ranked list of journals cited by the researchers. In all, 8100 articles were scattered in 548 journals. However, the top 10 journals account for more than half of the citations. The journal *Journal of Chemical Physics*' (USA) topped the list with 744 citations followed by *Indian Journal of Pure and Applied Physics* (India) with 585 citations and *Indian Journal of Physics* (India) with 456 citations.

Table 4: Ranked list of cited journals

Sl No	Rank	Title of the Journal	Country	Total Citations	Cumulative Citations
1	1	J Chem Phys	US	744	744
2	2	Ind J pure & Appl. Phy.	India	585	1329
3	3	Ind J Phys	India	456	1785
4	4	Spectrochim Acta	US	420	2205
5	5	Phys Rev	US	357	2562
6	6	J Phys Chem	US	311	2873
7	7	Chem Phys Lett	Netherland	243	3116
8	8	J Chem. Soc	UK	196	3312
9	9	J Am Chem Soc	US	195	3507
10	10	Cur Sci	India	148	3655
11	11	J Phys	France	125	3780
12	12	Ind J Chem	India	119	3899
13	13	Phys Rev Lett.	US	108	4007
14	14	Ind J Pure & Appl Sci	India	101	4108
15	15	J Appl Phys	US	98	4206
16	16	Chem Phys Lett	China	93	4299
17	17	Z Naturforsch	Germany	82	4381
18	18	Phys Chem	Germany	80	4461
19	18	Bull Chem Soc	Japan	80	4541
20	19	Adv Quant Chem	US	68	4609
21	20	Chem. Phys	Czechoslovakia	67	4676

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Sl No	Rank	Title of the Journal	Country	Total Citations	Cumulative Citations
22	21	Rev Mod Phys	US	61	4737
23	22	J Photochem Photobiol	US	55	4792
24	23	J Lumin	Netherlands	46	4838
25	24	Appl Phys Lett	Germany	45	4883
26	24	J Sci & Ind Res	India	45	4928
27	25	Phys Stat Sol	Germany	41	4969
28	25	Signal Processing	Netherlands	41	5010
29	26	J Mol Spectrosc	US	40	5050
30	27	Nuc Instr Meth	Holland	39	5089
31	28	Acta Phys Pol	Poland	38	5127
32	28	Chem Rev	US	38	5165
33	28	J Inorg Nuc Chem	US	38	5203
34	29	J Mol liq	Netherlands	36	5239
35	30	IEEE Trans Circ. Th.	US	35	5274
36	30	Mol Cryst Liq Cryst	UK	35	5309
37	31	IEEE Trans Ant. Prop	US	33	5342
38	32	Phys Lett	Holland	32	5374
39	32	Z Phys	Turkey	32	5406
40	33	J Ind Chem Soc	India	31	5437
41	33	IEEE	US	31	5468
42	34	Surf Sci	Holland	30	5498
43	34	Inorg Chem Acta	US	30	5528
44	35	Can J Chem	US	28	5556
45	35	J Chem Phys	US	28	5584
46	35	J Phys Radium	France	28	5612
47	35	J Phys Soc	Japan	28	5640
48	36	X Ray Spectrom	UK	27	5667
49	37	Anal Chem	Romania	26	5693
50	37	Appl Spectrosc	US	26	5719
51	37	Can J Phys	US	26	5745
52	37	Rev Sci Instrum	US	26	5771
53	38	Monatsh Chem	US	25	5796
54	39	Trans Met Chem	Hungary	24	5820
55	40	Radiat Phys Chem	US	23	5843
56		5 jls. with 22 citations each		110	5953
57		5 jls. with 21 citations each		126	6079
58		6 jls. with 20 citations each		120	6199
59		2 jls. with 19 citations each		38	6237
60		4 jls. with 18 citations each		72	6309
61		6 jls. with 17 citations each		102	6411
62		3 jls. with 16 citations each		48	6459

Sl No	Rank	Title of the Journal	Country	Total Citations	Cumulative Citations
63		6 jls. with 15 citations each		90	6549
64		5 jls. with 14 citations each		70	6619
65		5 jls. with 13 citations each		65	6684
66		6 jls. with 12 citations each		72	6756
67		4 jls. with 11 citations each		44	6800
68		7 jls. with 10 citations each		70	6870
69		17 jls. with 9 citations each		153	7023
70		10 jls. with 8 citations each		80	7103
71		14 jls. with 7 citations each		98	7201
72		32 jls. with 6 citations each		192	7393
73		18 jls. with 5 citations each		90	7483
74		35 jls. with 4 citations each		140	7623
75		50 jls. with 3 citations each		150	7773
76		74 jls. with 2 citations each		148	7921
77		179 jls. with 1 citation each		179	8100
<b>Total</b>		<b>548 Journals</b>		<b>8100</b>	<b>8100</b>

Such ranked list of journals can be used by libraries and research workers to select the journals of greater importance, productivity, and impact in a particular subject area.

#### 4.7 Half-life of Journal Citations

‘Obsolescence’ is a term that frequently occurs in the literature of bibliometrics and citation analysis studies. Analysis of citations by age of the cited documents can indicate the ‘useful life’, or the ‘Half-Life’ or the ‘Obsolescence rate’ of the documents’. The half life of literature used for any study in a particular discipline depends on the number of years respectively needed to satisfy one half of all the literature cited on the subject or one half of the citations made to the literature in the current year.

To calculate the half life of journal citations in the present study, a graph was plotted using the data given in Table 2 of chronological distribution of journal citations. Taking the period of years at the interval of ten years on x-axis against cumulative number of citations on the y-axis the graph was drawn from the point “P” (representing half the number of total citations) to meet the curve at point “Q”; a perpendicular “QR” is drawn to the x-axis (Fig.3).



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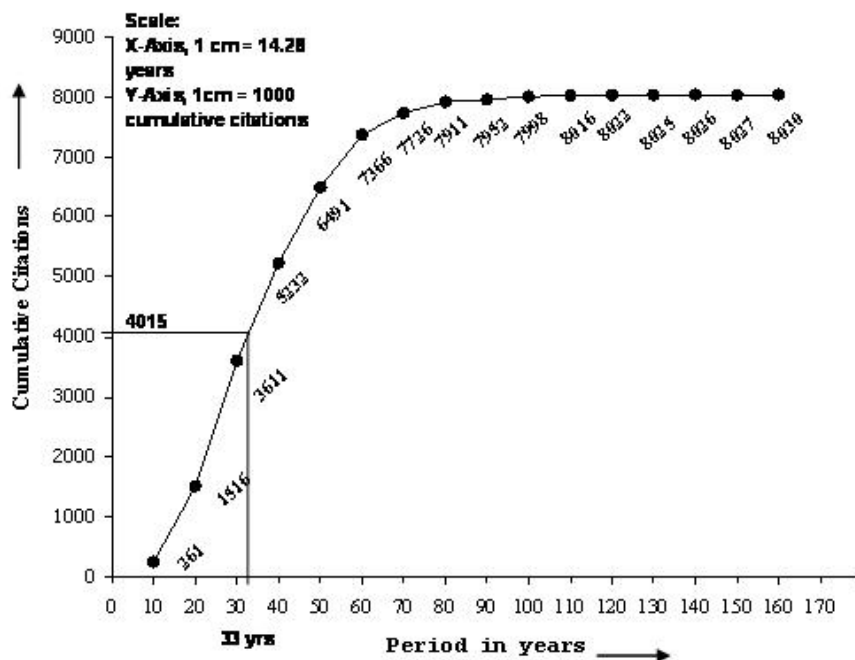


Fig. 3: Half life period of journal citations

The line “OP” represents the half of the total (8,030) citations i.e. 4,015 and the line “QR” represents the half life period for journal citations, which falls on an average for 33 years. The half-life period of the journal citations for the current analysis can be taken as 33 years.

### 4.8 Bradford’s Law of Scattering

Bradford’s law states: “If scientific periodicals are arranged in order of decreasing productivity of articles on a given subject that may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus when the number of periodicals in the nucleus and succeeding zones will be as 1: n: n<sup>2</sup>”.

The graphical and verbal interpretation of Bradford’s Law of Scattering was applied to citations in Physics. Table 5 lists journals in decreasing frequency of citations. To test applicability of Bradford’s Law of Scattering, a graph was plotted by taking the cumulative number of citations on ‘y-axis’ and log of cumulative number of journals on ‘x-axis’. The curve starts rising exponentially and then linearly indicating that the data fits Bradford’s Law.

From the graph, it can be observed that an experimental curve is closely in association with the theoretical (straight) line up to about 7,000 citations and then starts dropping as shown in Fig. 4 – Bradford’s bibliography

The citations were grouped into three zones of 1785, 5309 and 7186 respectively. Table 5 shows the scatter of Physics literature conforms to Bradford’s scatter. The Bradford’s multiplier factor is calculated by using equation (8). The multiplier factors for two zones are 6 and 4.44 respectively; the mean of these factors is 5.2. From Table 7, the findings can be shown that the data follows Bradford’s Law, that is:

$$\begin{aligned} 6 * 1 &= 6 \\ 6 * 5.2 &= 31.2 \\ 6 * 5.2 * 5.2 &= 162.24 \end{aligned}$$

In other words, it is 1: Z: Z<sup>2</sup> which is a proof of Bradford’s Law.

**Table 5: Distribution of cited journals by decreasing frequencies of citations**

No. of Journals	Cumulative No. of Journals	Log of Cumulative Journals	No. of Citations	Total Citations	Cumulative Citations
1	1	0	744	744	744
1	2	0.3	585	585	1329
1	3	0.48	456	456	1785
1	4	0.6	420	420	2205
1	5	0.7	357	357	2562
1	6	0.78	311	311	2873
1	7	0.85	243	243	3116
1	8	0.9	196	196	3312
1	9	0.95	195	195	3507
1	10	1	148	148	3655
1	11	1.04	125	125	3780
1	12	1.08	119	119	3899
1	13	1.11	108	108	4007
1	14	1.15	101	101	4108
1	15	1.18	98	98	4206
1	16	1.2	93	93	4299
1	17	1.23	82	82	4381
2	19	1.28	80	160	4541
1	20	1.3	68	68	4609
1	21	1.32	67	67	4676
1	22	1.34	61	61	4737

Citation Analysis of Ph.D. Theses

No. of Journals	Cumulative No. of Journals	Log of Cumulative Journals	No. of Citations	Total Citations	Cumulative Citations
1	23	1.36	55	55	4792
1	24	1.38	46	46	4838
2	26	1.41	45	90	4928
2	28	1.45	41	82	5010
1	29	1.46	40	40	5050
1	30	1.48	39	39	5089
3	33	1.52	38	114	5203
1	34	1.53	36	36	5239
2	36	1.56	35	70	5309
1	37	1.57	33	33	5342
2	39	1.59	32	64	5406
2	41	1.61	31	62	5468
2	43	1.63	30	60	5528
4	47	1.67	28	112	5640
1	48	1.68	27	27	5667
4	52	1.72	26	104	5771
1	53	1.72	25	25	5796
1	54	1.73	24	24	5820
1	55	1.74	23	23	5843
5	60	1.78	22	110	5953
5	65	1.81	21	105	6058
6	71	1.85	20	120	6178
2	73	1.86	19	38	6216
4	77	1.89	18	72	6288
6	83	1.92	17	102	6390
3	86	1.93	16	48	6438
6	92	1.96	15	96	6534
5	97	1.99	14	70	6604
5	102	2.01	13	65	6669
6	108	2.03	12	72	6741
4	112	2.05	11	44	6785
7	119	2.07	10	70	6855
17	136	2.13	9	153	7008
10	146	2.16	8	80	7088
14	160	2.2	7	98	7186
31	191	2.28	6	186	7372
19	210	2.33	5	95	7467
36	246	2.39	4	144	7611

No. of Journals	Cumulative No. of Journals	Log of Cumulative Journals	No. of Citations	Total Citations	Cumulative Citations
51	297	2.47	3	153	7764
76	373	2.57	2	152	7916
184	557	2.75	1	184	8100
<b>557</b>			<b>5564</b>	<b>8100</b>	

Fig. 4: Bradford's bibliograph

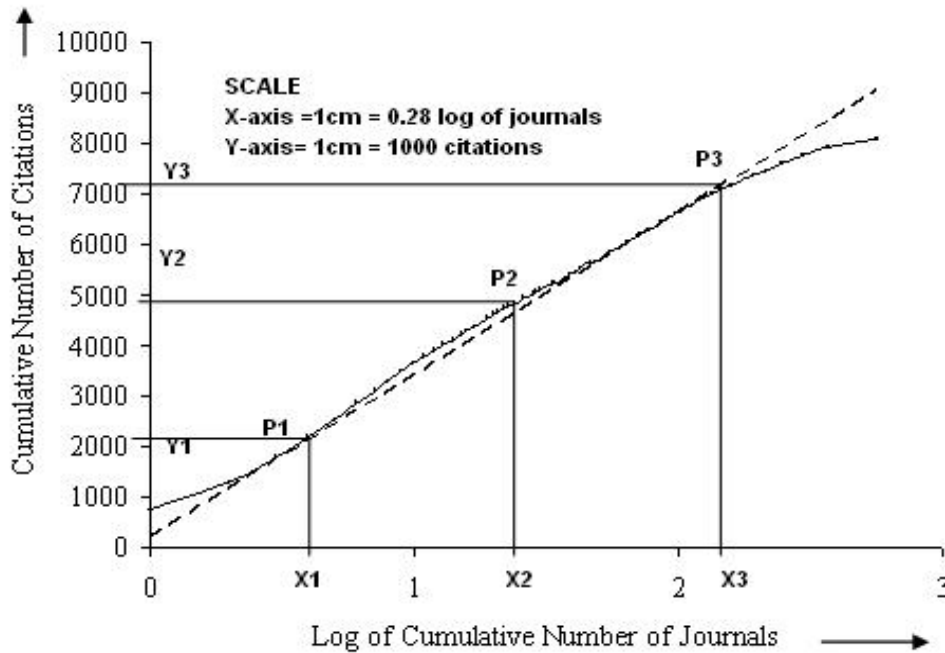


Table 6: Scattering of Citations in the Bradford's Zones

Zone K	Journals Pk	Cumulative Journals NK	Cumulative Citations R (k)	Citations of Zone mk	Multiplier factor Zk
1	4	4	2205	2205	---
2	20	24	7043	4838	5
3	122	146	14131	7088	6.1

## 5 FINDINGS OF THE STUDY

Following are some of the findings of the study:

## Citation Analysis of Ph.D. Theses

1. Out of the total 37 theses, 14 (37.84 %) theses were related to the subject Spectroscopy.
2. Journals constituted the most frequently used form accounting for 8,100 (80.54 %) citations of the total (10, 057) citations.
3. Collaborative authorship (two or more joint authors) of the cited papers was predominant accounting for about 35% of the citations.
4. The maximum number of journal citations belonged to the period 1980-1989 with 2095 (25.86 %) citations.
5. The maximum number of book citations belonged to the period 1960-1969 with 321 (29.15 %) citations.
6. *Journal of Chemical Physics*' (USA) topped the list with 744 citations followed by *Indian Journal of Pure and Applied Physics* (India) with 585 citations and *Indian Journal of Physics*. (India) with 456 citations.
7. The half-life period of the journal citations for the current analysis was 33 years.
8. Brad Ford's Law of Scattering fits to the present data with Multiplying Factor  $Z_k$  (average) = 5.55.

## 6 CONCLUSION

Findings of error-free citation analysis s provide guidance to librarians and researchers to take decisions in a situation where knowledge is growing exponentially, extensive scatter and seepage of information is becoming the norm, cost of documents is increasing and budgets are limited.

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