Analytical study of contents of LANL physics and cross-listed e-print archives, 1994-2002

E. R. Prakasan, Anil Kumar, Anil Sagar, Lalit Mohan, Sanjay Kumar Singh,
V. L. Kalyane and Vijai Kumar

Library and Information Services Division,
Bhabha Atomic Research Centre, Trombay, Mumbai– 400 085, India
E-Mail : prak@magnum.barc.ernet.in

Abstract

The frontiers of physics and cross-listed e-print archives posted during the years 1994-2002 at http://www.arxiv.org/archives/physics web service of Los Alamos National Laboratory (LANL) are explored from 7770 submissions. E-print archives posted to top most six physics-cross-listed research categories besides physics (5390) are: Condensed matter (754), Quantum physics (279), Astrophysics (222), Chemical physics (129), High energy physics - Phenomenology (118), and High energy physics-Theory (100). Prominent contributors are B.G. Sidharth (India), V.V. Flambaum (Australia), Antonina N. Fedorova (Russia), and Michael G. Zeitlin (Russia). Most preferred journals for rechannelising e-print archives are Physical Review Letters, Physical Review A, Physical Review E, Nuclear Instruments and Methods A, and Journal of Chemical Physics.

KEYWORDS/DESCRIPTORS: Scientometrics; Cybermetrics; E-print Archives; Web Services; *arxiv.org*; Biological Physics; Chemical Physics; Astrophysics; Computational Physics; Statistical Mechanics; Accelerator Physics; Free Flow of Scientific Information

1 INTRODUCTION

Engineers, scientists, and other researchers have always felt that it is easier to conduct research than publishing it in journals. Hence, the practice of alternative channels (letter writing, poster presentation, demonstration, informal meetings, short notes of work in progress, conferences, technical reports, pre-prints, etc.) are very often adopted for free flow of scientific information.

1.1 Non-Peer-Reviewed Pre-Prints:

A pre-print is the earliest form of publicly available research [1-2]. Pre-prints are pre-refereed, pre-publication papers. Pre-print is a good way of establishing priority. In a fast moving field as soon as research results are available, it is important to put the work as quickly as possible into the public domain with researchers name attached to it. Publication in journal are usually too slow. Pre-prints on the other hand could be produced quickly and circulated immediately by mail to other researchers in order to establish priority. Pre-print is a way of soliciting comments on the research so that the paper could be refined for formal publication. On receipt of comments, a paper would then be redrafted for submission to a journal. For a discipline as a whole, pre-print is a way of reducing the likelihood of unnecessary duplication of research.

However, paper pre-prints are not entirely satisfactory. For a start, they do not halt all disputes over priority. Another key problem has to do with distribution. Distribution is inevitably limited. Only certain institutions receive pre-prints; others (including most institutions in underdeveloped countries) are effectively out of the loop. Researchers in these places are at a distinct disadvantage.

1.2 Non-Peer-Reviewed E-Print Archives:

The e-print (electronic pre-print) archives were originally designed as a way of automating the paper-based process already in existence. E-print archives are globally accessible open depository of non-peer-reviewed research. Anyone with access to a networked computer can now look at the pre-print literature. The e-print archives are democratizing the scholarly communication process. Now the e-print archives services of research output are like newspaper services, with a similar longevity [3].

Scholarly publication forms the intellectual core of any discipline [4]. Facilities of free, open, discipline-based access to e-print and re-print are the responses of many scholarly communities to the tactics of the commercial journal publishers who are perceived to profit unreasonably from scholarly work [5-6]. The usefulness will be further enhanced by the implementation of techniques for automatically detecting the occurrence of citations within texts [7], and creating active hyperlinks on that basis [8]. Such techniques have been developed in a series of exploratory projects conducted in a variety of contexts, including the Open Journal Project [9], the Open Citation Project [10], NECs Research Index [11], and Ex Libris SFX framework for dynamic, context-sensitive linking [12-13]. Interoperability among the various emerging "standards" for automated citation-detection and link-creation is one of the primary goals of the Sante Fe Convention [14], developed by the Open Archives Initiative. The citation-detection process itself may be made easier through widespread adoption of a standard format specification such as the Scholarly Link Specification Framework [15].

1.3 Non-Peer-Reviewed and Peer-Reviewed Physics and related E-Print Archives:

James Langer, President, American Physical Society, stated that we need a system for diffusing and archiving scientific information that can grow and change rapidly in size, complexity, and accessibility. Both non-refereed e-print archives and refereed journals would be essential components of that system [16].

Physicists check the site every day for new information. They post all their papers there, cite references by archives number, use the search engine to find other papers, and need little or no other publication services. Publications on the archives services are instantaneous. It costs the users nothing and is self-organizing. Physicists all over the world can post their research results without any hassles. In that sense it is far more democratic. They do not have to be part of preprint mailing lists and they can find out what is new on the archives just as soon as everyone else does.

Los Alamos National Laboratory (LANL), USA started a multidisciplinary e-print archives services in the early 1990s. It was a brainchild of Paul Ginsparg, [17]. It is currently known as *arxiv.org* (formerly known as Los Alamos XXX service). It processes over 200 new submissions per day. This new system of scientific communication is doing far more than just providing an ultra-effective mode of operation for scientists. It is forcing a complete reevaluation of the role of scholarly journals and, inevitably, an equally thorough reevaluation of the roles of those organizations, as their stated mission is the advancement and diffusion of the knowledge of physics.

The current pattern of usage of *arXiv* looks something like this:

A researcher prepares his/her work in one of the formats accepted on *arXiv* ;

The author self-archives by e-mail or FTP or using the submission procedure on the Web and the document gets an *arXiv* document number ;

Other researchers go through it by finding out from the *arXiv* web interface or through e-mail alerting services ;

Comments of other researchers are received by the author through e-mails ;

The author then revises the paper in response to the comments and replaces the original paper with the revised one. The paper may undergo a number of revisions ;

The paper is then submitted to a journal for publication. Some journal publishers now even allow submission in the form of an *arXiv* document number. The referees can refer the paper on *arXiv* ;

As per the referees comments the paper is either accepted or rejected ;

If rejected, the paper may be submitted to another journal after any necessary revisions. Revised versions may be included on *arXiv* ; and

The process from journal part repeats. The final and revised version is also placed on *arXiv*.

Most preprints are issued with a preprint number assigned by the host institutions of author. This number identifies the paper within the institution and distinguishes it from preprints issued by other institutions. The preprint numbers are not standardized, so it is difficult to group and uniquely identify them in a database.

The e-print archive number assigned by xxx.lanl.gov (the LANL preprint server) provides a standardized common number for preprints that allows the item to be uniquely identified regardless of the institution from which it has originated. The e-print archive number is also useful for citing the work, as well as serving as a common link between databases consisting of bibliographic information and the full text of the article.

LANLs alphanumeric code of e-print archive number consists of broad subject categorization, year indicator, and accession number [18]. The e-print archive number is a useful form of identification and serves as a linking point for electronic publications. The SLAC SPIRES database and the Astrophysical Data System (ADS) at Harvard use the e-print archive number to link their bibliographic (database) records to the full text electronic versions at LANL. Eventually, links could be established using the e-print archive number (or some other mutually agreed identifier) to track an article throughout its publication process, from inception to final publication, and to reuse the data in future publications [19].

The format of the e-print archives holdings on the web interface includes many links to archives added on the same day, in last five days, different versions of each and every e-print archives, etc.

Studying the service of e-print archives of multidisciplinary nature with a stated mission of the advancement and diffusion of the knowledge of physics is obviously interesting. This paper describes the discipline-wise growth pattern and content analysis of e-print archives for physics and related disciplines available online at *arxiv.org.*

2 MATERIALS and METHODS

A total of 7770 e-print archives posted in the physics and cross-listed categories (including mathematics, non-linear sciences, computational linguistics and neuroscience) on *http://www.arxiv.org/archives/physics* during 1994 to 2002 are considered for the present study. Content analysis has been carried out on the three fields namely ‘Category code’, ‘Authors’, and ‘Journal-ref’ for the scientometrics or cybermetrics of archived information.

3 RESULTS and DISCUSSION

3.1 Growth of physics and cross-listed e-print archives:

A near linear and steady growth in the number of physics and cross-listed e-print archives was observed. Among the total of 7770 e-print archives considered, 75% of them are added during 1999-2002. Research category-wise chronological distribution of physics and cross-listed e-print archives is presented in Table 1. Figure 1 depicts the growth pattern of physics and cross-listed e-print archives. The growth pattern of six cross-listed subject categories is depicted in Figure 2. All of the subject categories have shown a steady and positive growth rate except for Chemical Physics. During the period 1996-1997, there is a rapid growth in the number of e-print archives for 'Quantum Physics' and 'High Energy Physics -Phenomenology'.

Prominent authors of physics and cross-listed e-print archives:

Total authors observed in the bylines of the 7770 e-print archives were 12331. Number of authors having only one e-print to their credit was 8898. Linear curve in log-log scale for the Lotka's Law [20-23] for the observed, expected (α = 2), and modified (α = 2.3) values are depicted in Figure 3.

Physicists are always one step forward in accepting new technological opportunities and challenges. Contributions of individual physicists (Table 2) from India and Australia are high. B.G. Sidharth of Centre for Applicable Mathematics & Computer Sciences, B. M. Birla Science Centre, Hyderabad (India) has contributed 57 items to the physics and cross-listed e-print archives.

Table 1: Year-wise distribution of the physics and cross-listed e-print archives (1994-2002)

Research Discipline	1994	1995	1996	1997	1998	1999	2000	2001	2002	Total
Physics			72	390	589	743	1144	1226	1226	5390
Condensed Matter		1	12	70	106	100	144	156	165	754
Quantum Physics			3	22	44	41	69	51	49	279
Astrophysics			8	15	28	30	52	52	37	222
Chemical Physics	40	51	38							129
High Energy Physics – Phenomenology		1	2	10	11	17	28	24	25	118
High Energy Physics – Theory			9	31	15	7	10	13	15	100
General Relativity and Quantum Cosmology			3	6	12	17	18	15	19	90
Nonlinear Chaotic Dynamics							24	31	30	85
High Energy Physics – Experiment		1	1	2	5	12	36	8	13	78
Nuclear Theory			2	9	11	12	15	12	9	70
Atomic Physics		15	53							68
Mathematical Physics					5	18	8	10	16	57
Chaotic Dynamics			2	6	23	18				49
Accelerator Physics	4	21	22							47
Nonlinear Pattern Formation and Solitons							12	13	12	37
Plasma Physics		16	12							28
Pattern Formation and Solitons			3	3	5	6				17
Quantum Algebra and Topology			7	7						14
Atmospheric and Oceanic Physics		8	5							13
High Energy Physics – Lattice			1		2	2	5		3	13
Nuclear Experiment			1	1		2	4	3	2	13
Data Analysis, Statistics and Probability		8	3							11
Mathematical Physics Analysis of PDEs					1	2	2	5		10
Adaptation and Self Organizing Systems			1		5	3				9
Nonlinear Adaptation and Self Organizing Systems							3	1	4	8
Mathematical Physics Numerical Analysis					1		1	3	2	7
Differential Geometry			1	5						6
Exactly Solvable and Integrable Systems			1	2	3					6
Computational Physics;Gases				1	2	1				4
Mathematical Physics Probability Theory							1	2	1	4
Computer Science. Computational Complexity								2	1	3
Functional Analysis				3						3
Mathematical Physics Differential Geometry					3					3
Nonlinear Cellular Automata and Lattice Gases								1	2	3
Nonlinear Exactly Solvable and Integrable Systems								1	2	3
Computer Science. Computer Vision and Pattern Recognition							1	1		2
Computer Science. Distributed, Parallel, and Cluster Computing								1	1	2
Computer Science. Learning; Logic in Computer Science						1			1	2
Computer Science. Neural and Evolutionary Computing					1				1	2
Mathematical Physics Functional Analysis					2					2
Computer Science. Computational Engineering									1	1
Computer Science. Computational Geometry									1	1
Computer Science. Computers and Society						1				1
Computer Science. Symbolic Computation							1			1
Mathematical Physics Combinatorics									1	1
Mathematical Physics Dynamical Systems						1				1
Mathematical Physics Geometric Topology									1	1
Mathematical Physics Representation Theory						1				1
Neuroscience Behavioral Systems						1				1
Total E-prints	44	122	262	583	874	1036	1578	1631	1640	7770

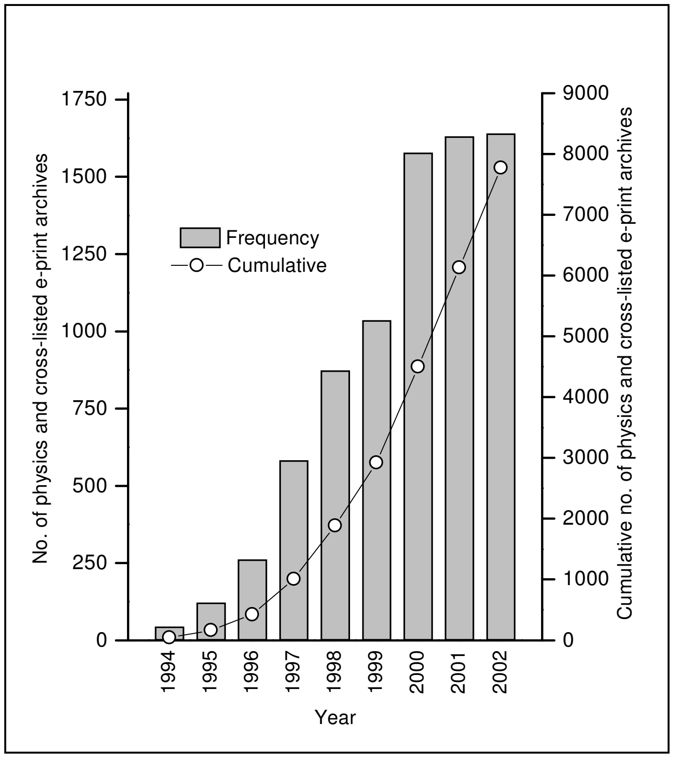

Figure 1: Year-wise frequency and growth of physics and cross-listed e-print archives

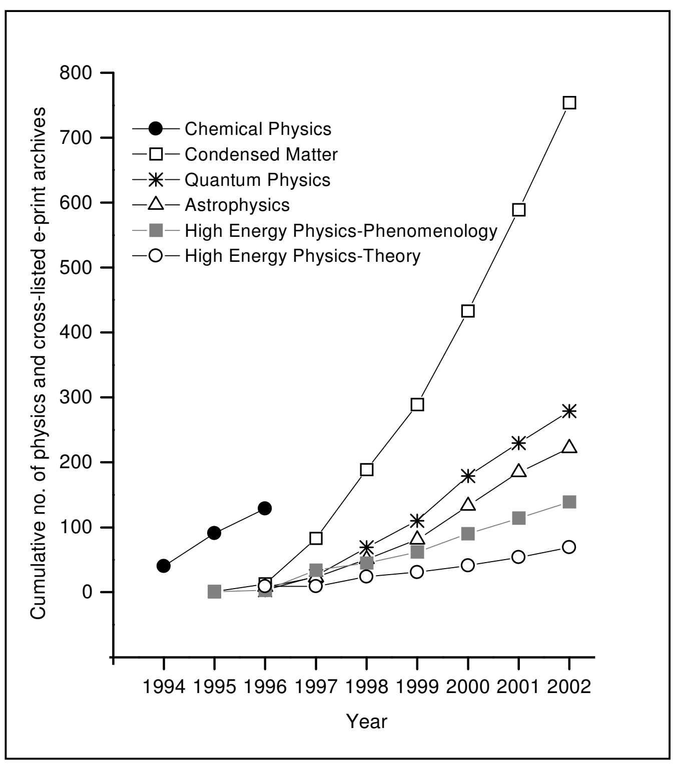

Figure 2: Growth of top most six categories of cross-listed e-print archives

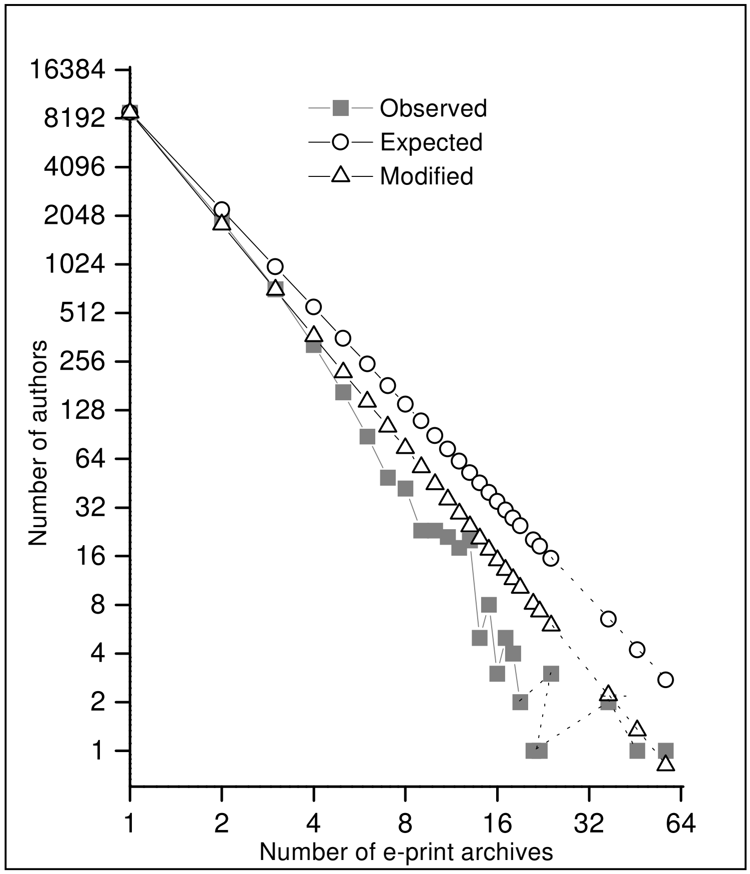

Figure 3: Author productivity in physics and cross-listed e-print archives (1994-2002) observed, expected (α=2) as per Lotka's Law, and modified Lotka's Law (α=2.3) presented in log-log scale

3.3 Resubmission of physics and cross-listed e-print archives to conference or journal:

It is not necessarily certain that the preprints will be published, and the type of publication in which they might appear may vary greatly. Some might appear in highly respected research journals, while others exist only as internal technical reports of the research centre. Some preprints never appear in any form other than a preprint. The goal of the preprint is to quickly disseminate research information, avoiding the long publication delay commonly associated with refereed journals [24].

Table 2: High productive authors observed in the physics and cross-listed e-print archives (1994-2002)

Sl. No.	Author	(Affiliation)	No. of e-prints
1	B. G. Sidharth	(India)	57
2	V. V. Flambaum	(Australia)	46
3	Antonina N. Fedorova	(Russia)	37
4	Michael G. Zeitlin	(Russia)	37
5	Holger F. Hofmann	(Japan)	24
6	Kirk T. McDonald	(USA)	24
7	Sadhan K. Adhikari	(Brazil)	24
8	H. C. Rosu	(Mexico)	22
9	Lawrence R. Pratt	(USA)	21
10	Kikuo Harigaya	(Japan)	19
11	R. Jackiw	(USA)	19
12	Ulrich H.E. Hansmann	(USA)	18
13	E. L. Afraimovich	(Russia)	18
14	M. Kibler	(France)	18
15	Luis Gonzalez-Mestres	(-)	18
16	D. M. Snyder	(-)	17
17	Roger Ellman	(USA)	17
18	Valery Telnov	(Russia)	17
19	Jan ML Martin	(-)	17
20	P. R. Berman	(-)	17
21	Krzysztof Sacha	(Poland)	16
22	Sameen Ahmed Khan	(Mexico)	16
23	Uzi Landman	(USA)	16
24	Alex Kaivarainen	(Finland)	15
25	Alexander A. Vlasov	(Russia)	15
26	Constantine Yannouleas	(USA)	15
27	D. Andelman	(Israel)	15
28	L. Ya Kobelev	(Russia)	15
29	R. M. Jones	(USA)	15
30	William Bialek	(USA)	15
31	E. G. Bessonov	(-)	15
32-36	5 authors		14
37-54	18 authors		13
55-74	20 authors		12
75-95	21 authors		11
96-118	23 authors		10
119-141	23 authors		9
142-183	42 authors		8
184-232	49 authors		7
233-320	88 authors		6
321-485	165 authors		5
486-809	324 authors		4
810-1528	719 authors		3
1529-3433	1905 authors		2
3434-12331	8898 authors		1

The analysis of the 'Journal-ref:' field has given an idea of how many e-print archives holdings have the information about the source in which these archives are formally published. Among the 7770 item studied 4397 (56.59 %) possess details of the source in which they are published.

The analysis of the sources reveals that physicists who are contributing to e-print archives preferentially publish their papers in e-Conferences.

Table 3 is a list of leading journals publishing physics and cross-listed e-print archives. Table 4 gives Bradfordian zones of almost equal number of articles scattered in various journals. Average Bradford multiplier is found as 10.87. Bradford-Zipf bibliograph plotted based on the productivity of the journals in terms of number of papers and their cumulative are depicted in Figure 4. The five core journals with Impact Factors (*Journal Citation Reports*-2001) publishing 1168 articles in the first zone are: *Physical Review Letters* (6.668), *Physical Review A* (2.81), *Physical Review E* (2.235), *Nuclear Instruments and Methods A* (1.26), *Journal of Chemical Physics* (3.147). Growth pattern of the papers in these highly preferred journals are presented in Figure 5. Hence, a library of an R&D institution where researchers are interested in physics related domains should subscribe to these five journals at least.

Zone II articles (1119) published in 45 journals should be retrieved through abstracting and indexing services (hard copy), electronic databases like INIS, INSPEC or the web services for latest publications.

Zone III articles have very wide scattering as 1157 articles were published in 573 journals. Hence it is recommended that the retrieval of these articles should be through linking processes e.g. citation databases like *Science Citation Index* (SCI) or the references cited in the articles from Zone I and Zone II.

Table 3: Journal titles publishing the physics and cross-listed e-print archives (1994-2002)

Sl. No.	Journal title	Published	Going to be published	Total
1	*Phy Rev Lett*	199	134	333
2	*Phy Rev A*	190	119	309
3	*Phy Rev E*	199	102	301
4	*Nuc Inst and Meth A*	102	29	131
5	*J Chem Phys*	61	33	94
6	*Phys Lett A*	71	19	90
7	*J Phys A*	65	20	85
8	*Phy Rev B*	43	26	69
9	*J Phys B*	50	11	61
10	*Phy Rev D*	50	6	56
11	*Comput Phys Comm*	31	16	47
12	*American Journal of Physics*	26	19	45
13	*Physica A*	30	9	39
14	*Europhys Lett*	26	12	38
15	*Chaos solitons & Fractals*	30	2	32
16	*Chem Phys Lett*	22	10	32
17	*Eur Phys J D*	15	13	28
18	*J Math Phys*	25	2	27
19	*Optics Communications*	15	12	27
20	*Astrophys Journal*	21	5	26
21	*Eur J Phys*	13	10	23
22	*Phy Rev C*	20	2	22
23	*Optics Letters*	11	10	21
24	*Physica D*	13	6	19
25	*Phys Rev ST Accel Beams*	16	2	18
26	*J Phys : Condens Matter*	13	3	16
27	*Molecular Physics*	11	5	16
28	*Phys Lett B*	15	1	16
29	*Physics of Plasmas*	20	12	32
30	*Found Phys*	12	3	15
31	*Found Phys Lett*	12	3	15
32	*Nuovo Cimento B*	11	2	13
33	*Astronomy & Astrophysics*	5	7	12
34	*Int J Mod Phys C*	9	3	12
35	*Int J Quantum Chem*	6	6	12
36	*Eur Phys J B*	7	4	11
37	*J Phys Chem B*	7	4	11
38	*Physics of Fluids*	8	7	15
39	*Proc Nat Aca Sci U S A*	11	0	11
40	*Review of Scientific Instruments*	4	7	11
41	*Hadronic Journal*	9	1	10
42	*Int J Mod Phys A*	8	2	10
43	*J Mod Opt*	7	3	10
44	*J Nonlinear Math Phys*	10	0	10
45	*JETP Lett*	8	2	10
46	*Optics Express*	9	1	10
47-52	6 journals	14	40	9
53-63	11 journals	17	71	8
64-71	8 journals	14	42	7
72-87	16 journals	27	69	6
88-98	11 journals	19	36	5
99-116	18 journals	24	44	4
117-157	41 journals	42	79	3
158-240	83 journals	56	109	2
241-623	383 journals	150	231	1
1-623	Total	1909	1426	2296

Table 4: Bradford's Zone-wise distribution of no. of papers in journals and respective Braford multipliers

Zone	No. of papers	No. of Journals	Bradford Multiplier
I	1168	5	-
II	1119	45	9
III	1157	573	12.73
Total	3344	623	10.87

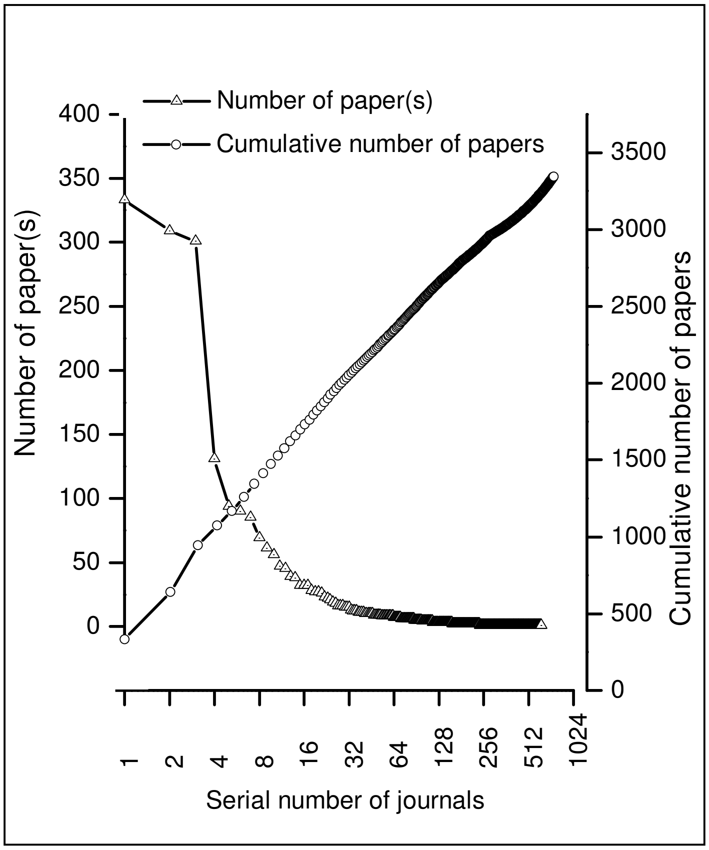

Figure 4: Number of paper(s) and cumulative number of papers having physics and cross-listed e-print archives (1994-2002), published in various journals in descending order of productivity (semi-log scale).

4 CONCLUSION

The physics and related interdisciplinary and multidisciplinary scientific community have conducted the most innovative and successful experiments in scholarly communication by the use of the *arXiv* server. Researchers use it for disseminating both pre-prints and post-refereed

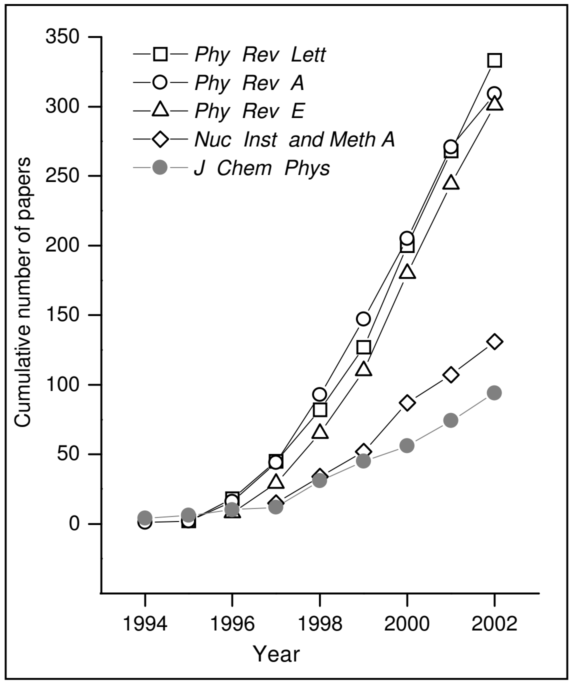

Figure 5: Cumulative number of papers in highly preferred journals publishing physics and cross-listed e-print archives (1994-2002)

articles. Interestingly, they still wish to have their work accepted by journals, and endorsed by the formal peer-review process, but do not see journals as the only means of dissemination and diffusion of their work. In other words, self-archiving is not seen as a substitute for publishing in peer-reviewed journals, but as a mechanism for accelerating the process of peer-review and improving quality of publication before submitting it to the journal. E-print archives of a significant number of articles, which are not published (61.49%) elsewhere, remains the only source for physicists for supplementing further research. Present study reveals some of the current hot areas of subject categories. Many dynamic leaders (researchers, librarians, and R&D managers) are realising the potential of e-print archives.

5 ACKNOWLEDGEMENTS

We are grateful to John Willinsky, Pacific Press Professor of Literacy and Technology, University of British Columbia, Vancouver, BS, Canada for the peer-review and suggestions to conduct research on E-prints or pre-prints in digital era [25].

6 REFERENCES

1. BROWN (Cecelia). The coming of age of e-prints in the literature of physics. *Issues in Science and Technology Librarianship*. 31, Summer; 2001.
2. PRAKASAN (ER), ANIL KUMAR, ANIL SAGAR, LALIT MOHAN, KALYANE (VL), VIJAI KUMAR and UPADHYE (Rekha P). E-Print archives: A fast emerging mode of electronic communication of pre-prints. *BOSLA One Day Seminar on Resource Management: Proceedings Volume*, Eds. Muttayya Koganuramath, B.S. Kademani, Satish Kanamadi and Savita Rao. 2003; p. 15-24.
3. O'CONNELL (Heath B). Physicists thriving with paperless publishing. *HEP Libraries Webzine*. 6; 2002.
4. BORGMAN (Christine L) and FURNER (Jonathan). Scholarly communication and bibliometrics. *Annual Review of Information Science and Technology*, ed. B. Cronin, New Jersey: Information Today, Inc. 36; .2002; p. 3-72. (http://skipper.gseis.ucla.edu/faculty/jfurner/HTML/arist02.pdf).
5. HARNAD (S). Scholarly skywriting and the prepublication continuum of scientific inquiry. *Psychological Science*. 1; 1990; 342-343.
6. HARNAD (S). Free at last: The future of peer-reviewed journals. *D-Lib Magazine*, 5, 12; 1999.
7. COGPRINTS (http://cogprints.soton.ac.uk/).
8. HITCHCOCK (S), CARR (L), JIAO (Z), BERGMARK (D), Hall (W), LAGOZE (C) and HARNAD (S). Developing services for open eprint archives: Globalisation, integration and the impact of links. In: *DL00: Proceedings of the 5th ACM Conference on Digital Libraries*, R. K. Furuta (Ed.) (San Antonio, TX, June 2-7, 2000) New York, NY: ACM Press; p. 143-151. (http://www.dlib.org/dlib/april99/van_de_sompel/04van_de_sompel-pt1.html)
9. HITCHCOCK (S), CARR (L), HALL (W), HARRIS (S), PROBETS (S), EVANS (D) and BRAILSFORD (D). Linking electronic journals: Lessons from the Open Journal project. *D-Lib Magazine*. 4, 12; 1998.
10. HARNAD (S) and CARR (L). Integrating, navigating, and analysing open e-print archives through open citation linking (the OpCit project). *Current Science*. 79; 2000; 629-638.
11. LAWRENCE (S), GILES (C L) and BOLLACKER (K). Digital libraries and autonomous citation indexing. *Computer*. 32; 1999; 67-71.
12. SOMPEL (H) and HOCHSTENBACH (P). Reference linking in a hybrid library environment, part 1: Frameworks for linking. *D-Lib Magazine*. 5, 4; 1999.
13. SOMPEL (H) and HOCHSTENBACH (P). Reference linking in a hybrid library environment, part 2: SFX, a generic linking solution. *D-Lib Magazine*. 5, 4; 1999.

14. SOMPEL (H) and LAGOZE (C). The Sante Fe Convention of the Open Archives Initiative. *D-Lib Magazine*. 6, 2; 2000.
15. DOYLE (M). Pragmatic citing and linking in electronic scholarly publishing. *Learned Publishing*. 13; 2000; 5-14.
16. LANGER (James). Physicists in the new era of electronic publishing. *Physics Today*. 53, 8; 2000; 35-38.
17. PINFIELD (Stephen). How do physicists use an e-print archives? *D-Lib Magazine*. 7, 12; 2001.
18. PRAKASAN (ER), ANIL SAGAR, ANIL KUMAR, LALIT MOHAN, GADERAO (CR), SURWASE (Ganesh), KADAM (Sandeep), KALYANE (VL) and VIJAI KUMAR. Nuclear Theory and Nuclear Experiment E-print Archives: *Science Citation Index* - based Analysis. *SIS 2004*, *Digital Information Exchange: Pathways to Build Global Information Society, 22nd Annual Convention & Conference*, Eds. Harish Chandra, P. Pichappan, and Ramesh Kundra (22-23 January 2004), IIT Madras, Chennai, Jointly organized by Central Library, IIT Madras, Chennai and Society for Information Science, New Delhi. pp. 172-183.
19. YOUNGEN (Gregory K). Citation patterns to electronic preprints in the astronomy and astrophysics literature. *Library and Information Services in Astronomy III, APS Conference Series*, 153; 1998. (http://www.stsci.edu/stsci/meetings/lisa3/youngeng.html).
20. POTTER (WG). Lotka's Law revised. *Library Trends*. 3, 1; 1981; 21-39.
21. KALYANE (VL) and SEN (BK). A bibliometric study of the *Journal of Oilseeds Research*. *Annals of Library Science and Documentation*. 42, 4; 1995; 121-141.
22. GUPTA (DK). Lotka's Law and its applications to author productivity distribution of psychological literature of Africa, 1966-1975 (2 pts.). In: *Handbook of Library Archives and Information Centres in India*. Gupta (B M) (Ed.). Vol. 13. New Delhi, Segment Books; 1996; p. 343-372.
23. DEOKATTEY (Sangeeta); KALYANE (VL); VIJAI KUMAR and PHOOL CHAND. Lasers in medical applications: R&D mapping. *BARC/2001/E/022*. 2001; 41 p.
24. ALLEN (RS). Physics information and scientific communication: Information sources and communication patterns. *Science & Technology Libraries*. 11, 2; 1991; 27-38.
25. WILLINSKY (John). Personal communication, August 23, 2003.