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CITATION ANALYSIS OF LANL HIGH-ENERGY PHYSICS E-PRINTS THROUGH *SCIENCE CITATION INDEX* (1991-2002)

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1. INTRODUCTION

1.1 Emergence of E-Print Archives

Not long ago scholarly communication involved mail, fax, or more recently, anonymous FTP, gopher, and electronic mail. Scientific journals started in the mid-seventeenth century with *Le Journal des Savants* and *Philosophical Transactions of the Royal Society of London*. Their purpose was to communicate laboratory experiment results, inventions, and meteorological data in physics, chemistry and anatomy [Bellis, 2002]. Increasing costs of peer-reviewed print and electronic journals, which are still the mainstay of scholarly publishing is necessitated an alternative system for the scholarly communication. There are tens of thousands of different refereed journals available, and no library or institution can afford subscriptions to them all.

In some subjects, where rapid transmission of knowledge is critical, electronic dissemination of preprints is an absolute necessity, with subsequent traditional publication becoming almost a formality. Releasing articles when they're ready, instead of waiting for an issue to be published in print, is essential in a world where delays of a year now seem absurd. In mathematics and physics, for example, formal publication provides archiving, which serves more to remind the scholarly community of the paper's initial appearance. Ultimately, formal publication serves as a vehicle to support the standing of the author. Also it is crucial that the researchers, who play a privileged role in this as both providers and consumers of the information, not only be heard but be given the strongest voice.

Branin and Case [1998] compared the growing imbalance between scholarly output and library resources, high and rising cost of scientific journals, and the economic problems. They have also discussed the possibilities of scholarly publications in digital age, benefits, fundamental changes needed in scholarly publishing, restructuring of scholarly archives, library model in the digital scholarly publication system etc.

As the number of articles increased and the process became slower, drafts of manuscripts were circulated. These preliminary publications were called preprints. Initially, distribution of preprints required mailings of multiple copies of manuscripts. The process of distribution became faster with the popularity of the facsimile in the 1970's [Youngen, 1998]. The Internet and e-mail distribution accelerated the use of preprints.

The exponential increase in electronic networking usage has opened new possibilities for formal and informal communication of research information. For some fields of physics,

the on-line electronic archives immediately became the primary means of communicating ongoing research information, with conventional journals entirely supplanted in this role. Researchers voluntarily subscribe and make aggressive use of these systems, which are being continued to grow rapidly. The current levels of technology and network connectivity are adequate to support these systems. For some fields of physics, especially high-energy physics, open (i.e. un-refereed) distribution of research works is going well and has advantages for researchers both in developed and undeveloped countries. The invention of the World Wide Web in the early 1990's revolutionized preprints distribution. The integration of multimedia and graphics added considerable value to preprints. Preprints in digital format are known as e-prints and the online databases from which they are distributed are called e-print archives. Until recently, e-print archives did not exist in all scientific disciplines.

D. Lim [1996] defines preprints as manuscripts, which may fall into one or more of the three categories:

- that have been reviewed and accepted for publication,
- that have been submitted for publication but for which a decision to publish has not been made, and
- that are intended for publication but are being circulated among peers for comment prior to being submitted for publication.

E-prints may be full-text preprints (not yet refereed and published) and post-print published) research papers and other materials that are made available in digital form, usually on the Internet. Institutions or organisations, as opposed to individuals, usually maintain e-print archives.

Placing you material in an e-print archive is not intended to replace the conventional peer-review system. For obvious reasons we cannot peer-review the material submitted to this archive. Placing your material here is simply an addition to normal publishing, in order to increase the visibility and distribution of your work. You can, of course, submit refereed material to the archive.

E-print archives traditionally focus on research papers/journal articles, technical reports, conference proceedings, postgraduate theses and book chapters. These systems are entirely automated (including submission process and indexing of titles/authors/abstracts), and allow access via e-mail, anonymous ftp, and the World Wide Web. The communication of research results occurs on a dramatically accelerated time-scale and much of the waste of the hardcopy distribution scheme is eliminated. In addition, researchers who might not ordinarily communicate with one another can quickly set up a virtual meeting ground, and ultimately disband if things do not pan out, all with infinitely greater ease and flexibility than is provided by current publication media.

It is important to distinguish the form of communication facilitated by these systems from that of usenet newsgroups or garden variety "bulletin board" systems. In "e-print

archives", researchers communicate exclusively via research abstracts that describe material otherwise suitable for conventional publication. This is a very formal mode of communication in which each entry is archived and indexed for retrieval at arbitrarily later times. Usenet newsgroups and bulletin boards, on the other hand, represent an informal mode of communication, more akin to ordinary conversation, with un-indexed entries that typically disappear after a short time.

1.2 Present Concerns of E-Print Archives

How did an initiative in scholarly self-publishing and interoperable dissemination end up with "archive" in its name, with all of that term's connotations of longevity, authenticity, and integrity? [Hirtle, 2001]. The questions at the beginning of the e-print archive services were:

- Whether preprints should accept or not for print publication after electronic posting?
- The threat commercial journal publishers feel electronic pre-prints represent to this revenue, and discussion about government involvement in e-print publishing. In a word, it's all about money.
- "Durability" or the issue of archival survival is yet another misgiving.
- Issues like Plagiarism and Copyright.
- Metadata for e-print archives.

But true e-prints are very different—questions of time stamping, authentication, protection of intellectual property, version control, and archiving are generally considered necessary for e-prints to have an acceptable future in the academic community. And to some, e-prints are the solution to overcoming both the long-standing problems of delays in publishing and the staggering costs of commercial publishers.

The software used to set up the archive services is freely available at the eprints.org website. This system is not particularly difficult to set up and configure, and is fully capable of running an institutional e-print archive such as this one. Other institutions are encouraged to set up their own archives using this software. The more e-print archives that are in use, the more everybody in the community benefits.

Universities are emerging as principal caretakers of e-prints, but foundation for creating a universal archive is yet to emerge. The solution may lie in E-Prints, new software developed by the Electronics and Computer Science Department at the University of Southampton (http://www.eprints.org). This generic version is fully interoperable with other open archives, according to the agreement reached at the October 1999 Open Archives Initiative (OAI) meeting in Santa Fe, New Mexico (http://www.openarchives.org). OAI seeks to develop and promote interoperability standards to facilitate the efficient dissemination of content. Whereas the Open Archival Information System (OAIS) initiative arose from a need to ensure that scientific data would still be accessible in the future, OAI grew from a desire to enhance access to e-print archives as a means of increasing the availability of scholarly communication. OAI

is one of the most exciting developments in the area of information dissemination, and holds out the promise of radically changing how we access and use scholarly information.

There are currently about 70 OAI compliant archives registered, and various others using different systems. More archives are appearing as authors and their institutions realise the potential benefits of e-prints [“Frequently Asked Questions”].

The Open Citation Linking Project (OpCit) is a funded project, currently developing tools to make the existing resources more powerful by completely citation inter-linking all of the papers in The Los Alamos E-print Archive (arXiv) and eventually to extend this to all the rest of the disciplines in other open archives. The user need only click on the citation to view that paper -- as long as it too is archived online. For the purposes of the third year project this investigation has been extended to investigate a previously unexplored avenue. A fundamental part of the usage of an on-line archive is the habits of the users themselves. The aim has been to extend the ongoing research by investigating the relation between the objective online indicators and the authors' own verbal reports of their practices and rationale in archiving their work [http://www.eprints.org/results/report.html].

E-prints are far more complicated than they might appear at first glance. At its simplest form, any scholar can take a paper, code it in HTML, and place it on whatever Web site he or she chooses—similar to going to a conference with a small stack of photocopied articles. Some scholars do, in fact, distribute e-prints this way, risking the wrath of traditional journals that often label these as “previously published works.” [Peek, 2000]. At its simplest, the situation with copyright is as follows: if you own the copyright on the material you wish to submit, you can do as you please with it. If you do not own the copyright, you must have permission to submit it to the archive.

1.3 High-Energy Physics E-Print Archives

The factors and components of scholarly communication in physics has brought together [Peoples] with the role of Physics Societies, How Physicists Use the Libraries, The Literature of Physics, Most Frequently Cited Physics Journals, Research Databases for Physics (Indexes and Abstracts), Related Databases for Physics, and Searchable Online Journal Collections for Physics.

The bibliographic control of high-energy physics pre–print literature has evolved over three decades from a manually produced, weekly print publication that was mailed to libraries and physics departments world wide to an interactive database that provides online access and hypertext links to the bibliographic data, abstract, full text, references, and citations within literally hours of the pre–print’s first appearance. Some of the key technology enabling this process was invented by physicists themselves, who together with a handful of librarians with unusual vision, repeatedly pushed the database’s limits to better fulfill an idea of comprehensive and universal desktop access to the field’s literature. To understand how this process developed, and how other fields can adapt the

revolution it has created to their circumstances, one must have some background in the culture and tools of high-energy physics.

High-energy physics is a relatively small community with a strong tradition of international collaboration. Most of the experiments conducted are done on large instruments called detectors located at approximately a dozen accelerator laboratories around the world. Often hundreds of physicists from many countries collaborate to propose, design, build, and run these experiments, which, from inception to conclusion, may last a decade. While experimentalists form large teams, theoretical high-energy physicists are scattered thinly about the globe, at approximately 3,000 university physics departments and laboratories [Kreitz et al., 1996]. As early networks were established, high-energy physicists quickly recognized their utility to share the work of widely scattered collaborators and to communicate new theoretical insights rapidly amongst colleagues [Taylor, 1994]. Researchers in this field began to rely on the precursors of the Internet to share not only electronic mail, but also software programs, data analysis, and early drafts of collaboratively written research papers [Doty, 1991].

Luisella Goldschmidt-Clermont, working librarian at CERN in the 1960s, and the first librarian to look into how libraries could setup an infrastructure to make some sense out of the jungle of preprints which was floating around, a part of the literature that up to then had mostly been ignored by the library community and still is in many disciplines, even many years later. Her contributions turned out to have a strong impact on both sides of the Atlantic. In the 1960s she was central to the development of the CERN preprint list and the SLAC Library preprint handling system, which ultimately led to both services being ready to move into computerized systems so early.

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The Stanford Linear Accelerator Center (SLAC) Library has been acquiring and cataloging high-energy physics pre–prints for almost thirty years. While the Library maintains a suite of databases for the worldwide high-energy physics community's use, its flagship database is called SPIRES–HEP (Stanford Public Information Retrieval System–High Energy Physics). Kreitz [1996] reported the accesses via WWW to SPIRES-HEP Database and SLAC Postscript Preprint Server from Apr 1993- Mar 1995.

The field of experimental high-energy physics is dominated by a relatively small number of large, highly-visible projects. High-energy physics projects frequently have long lifetimes - projects lasting 3-5 years or even longer are typical [Traweek, 1992]. Major high-energy physics experiments are carried out by large, multi-institutional collaborations, sometimes with budgets in the hundreds of millions of dollars. High-energy physicists have long lead the sciences in the use of electronic media for sharing working papers. For example, most high-energy physicists contribute draft articles to an electronic working paper server at the time of submission of the article to a paper journal. While the paper journals are still important for archiving and for prestige and reward allocation, these electronic working paper servers are frequently the primary means of formal communication [Kling and McKim, 2000]. The working paper (or "e-print") server at Los Alamos National Labs has become central in the communications system of the field (Odlyzko 1996). While the Los Alamos National Labs E-Print server is the best-

known of these electronic working paper servers in the U.S., it isn't the only one. There are about 11 others, (including the CERN preprint server at http://preprints.cern.ch/, DESY preprints at ftp://ftp.desy.de/pub/preprints/, and the American Physical Society at http://publish.aps.org/eprintl/).

The current centrality of the Web, in the form of these e-print servers, in high-energy physics is frequently attributed to the central role of high-energy physicists (most important, Tim Berners-Lee, from CERN) in having developed the basic protocols underlying the World Wide Web. However, the use of electronic working paper servers in high-energy physics predated the Web; early e-print servers used FTP (file transfer protocol) and electronic mailto collect and make available electronic working papers (Kreitz, et al., 1996). Even more importantly, high-energy physicists had a pre-print culture that long predated their use of electronic media. Physicists since the 1970s submitted articles to paper-based pre-print clearinghouses, that then redistributed the papers to interested researchers (Kreitz, etal. 1996).

The first database, hep-th (for High Energy Physics -- Theory), was started in August 1991 by Paul H. Ginsparg, a longtime champion of this alternative model of scholarship, and was intended for usage by a small sub-community of less than 200 physicists, then working on a so-called "matrix model" approach to studying string theory and two dimensional gravity. (Mermin [Reference Frame, Physics Today, Apr 1992, p.9] later described the establishment of these electronic research archives for string theorists as potentially "their greatest contribution to science."). Within a few months, the original hep-th had quickly expanded in its scope to over 1000 users, and after a few years had over 3800 users. More significantly, there are numerous other physics databases now in operation (see xxx physics e-print archives) that currently serve over 35,000 researchers and typically process more than 70,000 electronic transactions per day (i.e. as of 2/96; see the weekly stats for an overview of growth in World Wide Web usage alone at xxx.lanl.gov). ArXiv has without doubt improved the efficiency of scholarly communication and strongly challenged the well-established publishing industry. At present the archive contains 190 000 papers, augmented with some 100 new papers every day. ArXiv is estimated to distribute about 25 000 daily e-mail alerts and there are probably at least 35000 distinct daily users via the Web [Vigen, 2002]. This is all well and good, but doesn't it still remain an 'electronic clone' of what was carefully set up by Luisella Goldschmidt-Clermont and her colleagues in the early 1960s?

1.4 Statement of Problem

At present, self-archiving (placing your own work in an e-print archive) co-exists with normal refereed journal publishing. These materials can still be published in a conventional journal, but by also placing a copy in an e-print archive it is ensured that it is easily accessible to a wider audience. Placing pre-prints in an archive allows you to gain potentially valuable feedback before submitting you material for formal peer-review. There are a variety of e-print archives around the world, and many more are being set up. The main purpose of e-print archives is to make the material they contain more accessible to potential readers. These readers would not necessarily have access to whatever journal

or publication the work might also appear in. This increased distribution and accessibility increases the potential impact of the research - increased recognition and more citations. Through the use of e-prints and author self-archiving, however, the distribution and consequently the potential impact of the work can be greatly increased. Aside from the obvious increase in the spread of research and knowledge - a worthwhile goal in itself - this will lead to extra feedback, more citations and increased recognition for your work.

Many studies have been conducted to compare and contrast the citation patterns of e-print archives using the citation linking of one e-print archive service itself like Stanford Public Information Retrieval System's database of high-energy particle physics literature (SPIRES-HEP) and other citation indexes like SciSearch, etc. Results in the articles by Youngen [1998], Brown [2001], Prakasan et al. [2004] are very noteworthy. The ultimate goal of the study is the prediction of future trends in the ways high-energy physicists exchange information. In turn, the results will help forecast the role of librarians and information specialists in the organization, management, and dissemination of e-prints.

The present study focused on the citations in *Science Citation Index* to the e-print archives of Los Alamos National Laboratory (LANL) available at http://www.arxiv.org/, submitted under the four categories of the high-energy physics viz. high energy physics - experiment (hep-ex), high energy physics - lattice (hep-lat), high energy physics - phenomenology (hep-ph), and high energy physics - theory (hep-th).

1.5 Target Group

The present study is aimed at the target group of:

administrators of library and information science establishments;
biographers of library and information professionals;
computer and information technology managers;
documentalists;
e-prints archives managers;
faculty responsible for framing syllabus of library and information science course;
gatekeepers of information;
historians of science;
information scientists;
journal editors of library and information science publications;
knowledge managers;
lanl connected information science professionals;
library and information science journalists;
manpower developers in library and information science;
news group of library and information science;
open archives initiative systems managers;
policy makers of library and information science;
quality controllers of R&D in library and information science;
research and development managers;

scientometricians;
teachers of library and information science;
users of library and information science literature;
value additions to the library and information science;
web designers;
xxx.org beneficiaries;
young library and information scientists;
zero-budget self-archiving-authors etc.

2. THEORETICAL BACKGROUND

2.1 General aspects

Scientific progress is largely based on the open exchange of research data and results among scientists. Journals contribute to the scientific process as the means to not only communicate but also to certify the validity of the information through a peer review process and to establish a prestige ranking order among scientists.

Paul Ginsparg, a physicist at the Los Alamos National Laboratory (LANL), developed the first digital or electronic preprint archive in August 1991. Originally dedicated to papers in high-energy theoretical physics, the "arXiv.org e-Print archive" at http://www.arxiv.org/ took several months to attract 1,000 users; but presently it reports from 35,000 to 150,000 visits per day [http://www.eprints.org/results/report.html].

Paul Ginsparg [1994], brain behind the arXiv.org, reported the expansion of arXiv software to handle a total of 14 research disciplines (Table 1).

Table 1: Chronology of starting of the LANL E-Print Archive Services

Discipline	**Starting Month, Year**
High-energy particle theory (formal)	August, 1991
Algebraic geometry	February, 1992
High-energy particle theory (phenomenological)	March, 1992
Astrophysics	April, 1992
Condensed-matter theory	April, 1992
Computational and lattice physics	April, 1992
Functional analysis	April, 1992
General relativity/Quantum cosmology	July, 1992
Nuclear theory	October, 1992
Nonlinear sciences	March, 1993
Economics	July, 1993
High-energy experimental physics	April, 1994
Chemical physics	April, 1994
Computation and language	April, 1994

He had also stated that the database and distribution system could also serve over 20,000 users from more than 60 countries and processes over 30,000 messages per day; it was one of the largest and most active databases on the Internet. The system originally ran as a background job on a small Unix workstation (a 25 MHz NeXT station with a 68040 processor purchased for roughly $5000 in 1991), which was primarily used for other purposes by another member of his research group, and placed no noticeable drain on CPU resources. The system has since been moved to an HP 9000/735 that sits exiled on the floor under a table in a corner.

Jordan [1999] reviewed the status, challenges, and opportunities of the preprint servers, a new digital publishing paradigm with some definitions, an account of disciplinary preprint servers, a list of key preprint sites and future of preprint servers.

Tomaiuolo and Packer [2000] introduced e-print archives with the definitions of The U.S. Department of Energy, Office of Scientific and Technical Information and The American Physical Society. The article also presented the history of preprints, preprint usage, servers and searching, the question of peer-reviewing, effect on traditional publishing activity, the issues like plagiarism and copyright, and the future of preprints with a check list of preprint servers.

Till [2001] stated that the traditional (paper) 'preprints' are defined in several ways, depending on their stage in the conventional publication process. They can be manuscripts that are being circulated among peers for comments prior to submission for publication. They can have been submitted for publication, but no decision to publish has yet been made (usually referred to as 'submitted to . . .'). Or they can be manuscripts that have been reviewed and accepted for publication (usually referred to as 'in press . . .') [Youngen, 1998]. Of particular interest from the perspective of electronic preprints are those preprints that are intended for publication, and are self-archived by their authors either prior to, or after, acceptance for publication [Ginsparg, 1999]. However, 'e-print' (or 'eprint') can be defined in other ways. Here, the focus will be on 'e-preprints', with a particular emphasis on those that have been self-archived by their authors.

Luce [2001] has addressed the e-print revolution, definitions, user needs, Los Alamos arXiv, and evolution of arXiv software. Luce has reported the possibility of direct journal acceptance of articles through arXiv identifiers instead of requiring direct submission (e.g., American Physical Society: *Physical Review D*, Elsevier: *Physics Letters B*). Domain-wise submissions and mode of submissions of arXiv from 1996 to 2000 are presented in the work. High-energy physics e-print archives were leading in that period and among the modes of submission, procedures through web were gaining the momentum than through e-mails or ftp.

Brown [2001] stated that, despite the many advantages of e-prints including: immediate; modifiable; updateable; inexpensive; unlimited size, their use has yet to overtake that of traditional journals.

Many agree with Boyce [2000] that "preprint servers are here to stay" as evidenced by their growth in other scientific disciplines [Koenig, 2000; McConnell and Horton, 1999; Eysenbach, 2000].

Glaze [1999] commented that the principal argument for the control of electronic preprint publication is not to protect copyright, but it is to protect the integrity of scientific publications, ultimately for promoting good science or benefit society.

In fact, even though chemists are leery of the e-print mode of communication ["Should research be", 2000], in the summer of 2000, Chemical Abstracts Service announced plans

to index e-prints ["CAS will now ", 2000] and Elsevier launched its own free chemistry e-print server ["The Chemistry Preprint Server", 2000].

The ambition and benefits of National Institutes of Health (NIH) to setup a web based publishing venture (preprint publishing) that could radically change the way biology papers are disseminated have reported by Varmus [1999]. Koenig [2000] reported the movement of European Molecular Biology Organization (EMBO) to start 'E-Biosci', a free archive for biomedical papers, taking the cue from PubMed Central, U.S. counter part of this.

Warnick [2001] mentioned about PrePRINT Network, a web-based product of US Department of Energy (DOE), launched on 31st Jan., 2001. The PrePRINT Network is a searchable gateway to preprint servers all across the world, which deals with scientific and technical disciplines of concern to the DOE. With a single query, users can search one or a collection of existing preprint servers. The Network pulses the search engines of such servers, compiles the results, and returns them to the users (http:/www.osti.gov/preprint).

Marshall [1999] reported the organization of several economics related repositories in a site called Research Papers in Economics (RePEc, at http://www.netec.mimas.ac.uk/RePEc), coordinated by Thomas Krichel of the University of Surrey, U.K. and cognitive science, psychology, neurology, linguistics, and related papers at CogPrints (http://www.cogprints.soton.ac.uk) of Steven Harnad of the University of Southampton, U.K.

Carr et al. [2000] introduced Computing Research Repository (CoRR), a Computing Research Depository, formally launched in September 1998, but folded into the archive papers posted to the LANL computation and language (cmp-lg) archive that began in 1994, and papers from the electronic *Journal of AI Research* (JAIR), which are archived according to date of publication (not date of archiving). Hence CoRR appears to have a history of posting prior to its launch. The paper also discusses the need to promote CoRR more effectively for its intended community - computer scientists in universities, industrial research labs and in government. For that some points have taken up in detail on this new world of open archiving concerning central versus distributed self-archiving, publication, the restructuring of the journal publishers' niche, peer review and copyright.

Jackson [2002] emphasized the journey from preprint to e-print in mathematics with the rise and growth of electronic preprint servers in the field.

Till [2001] stated that although there was an early experiment in the 1960s with the central distribution of paper preprints in the biomedical sciences, these sciences have not been early adopters of electronic preprint servers. Some barriers to the development of a 'preprint culture' in the biomedical sciences are described in the paper. Multiple factors that, from the 1960s, fostered the transition from a paper-based preprint culture in high-energy physics to an electronic one are also described. It has been also stated that a new revolution in scientific publishing, in which journals come to be regarded as an overlay

on electronic preprint databases, will probably overtake some areas of research much more quickly than others.

Taubes [1996a, 1996b, 1996c] reported that popular physics journals (*The Physical Review*, *Physical Review Letters*, *Reviews of Modern Physics* etc.) publisher American Physical Society (APS), who were aware of the enthusiastic approach of physicists towards the virtues of the electronic preprint archives of Los Alamos National Laboratory for few years, went on-line with its own prototype preprint server (http://publish.aps.org/eprint/). APSs concepts regarding print to electronic, inflation cost per print article, decline in library journal subscription have discussed by Langer [2000].

Harnad [2001] has given an account of costs involved in the refereeing process in terms of archiving submitted papers on a website; selecting appropriate referees; tracking submissions through rounds of review and author revision; making editorial judgments, and so on. He stated that even though the financial access barriers have come down drastically, refereed research literature must be freed online for everyone, everywhere, for ever. Harnad firmly advocated the institution-based self-archiving.

In the context of scholarly publishing, a list of academic institutional repositories, electronic publishing projects, journal pre-print and e-print repositories, e-book repositories, and electronic journal archiving projects have presented ["New Models in Scholarly Publishing"]. Prakasan et al. [2003] have documented discipline-based e-print archive services. Among the discipline-based preprint servers the following are note worthy:

American Physical Society E-Prints http://publish.aps.org/eprint This server began in 1996 and, although a searchable archive, was closed to submissions on May 31, 2000. It now redirects authors to the Los Alamos site or to the American Physical Society's journals.
CERN Document Server: Preprints http://preprints.cern.ch/ Full text usually provided; coverage from 1994 onward. Includes links to other preprint servers.
Chemical Physics Preprint Database http://www.chem.brown.edu/chem-ph.html A joint project of the Los Alamos National Laboratory and Brown University's Chemistry Department. This archive hosts full-text documents for the international theoretical chemistry community.
ChemWeb http://www.chemweb.com/ Launched in July 2000. Allows free searching of chemistry journals as well as reviewed chemistry Web sites. Free citations and abstracts, but you must pay for full text by subscription or "pay as you go."
Clinmed Netprints http://clinmed.netprints.org/ Launched by the *British Medical Journal* and Highwire Press, this site provides a place for authors to archive their completed studies before, during, or after peer review by other agencies. It covers original research into clinical medicine and health and includes a warning that articles posted "have not yet been accepted for publication by a peer reviewed journal…Casual readers should not act on their findings, and journalists should be wary of reporting them." It also has a list under Journal Policies of which journals will and will not accept submissions that have appeared on preprint servers.
E-Math http://www.ams.org/preprints A preprint server for mathematicians, maintained by the American Mathematical Society. The mission of the server is to make available to the mathematical community the current home page URLs and e-mail contacts of all mathematical preprint and e-print servers throughout the world. The server itself does not offer full text, but can be used as a tool to link to servers that include text.
LANL's E-Print Archive http://xxx.lanl.gov/

Begun in 1991 by physicist Paul Ginsparg this well-organized, if somewhat user-unfriendly server, covers physics, mathematics, nonlinear science, and computer science. Full text is available in various electronic formats.
NCSTRL (Networked Computer Science Technical Reference Library) http://www.ncstrl.org/ Online since 1995, this server distributes technical reports in computer science. Searching and online access to full text is free.
PrePrint Network http://www.osti.gov/preprint Sponsored by the U.S. Department of Energy, this is a searchable gateway to preprint servers that deal with scientific and technical disciplines of concern to DOE. The gateway also includes scientific and technical disciplines such as physics, materials, and chemistry, as well as portions of biology, environmental sciences and nuclear medicine. Users can search across the gateway by author, title, full record, date, and collection, or browse the databases alphabetically or by subject pathway. Search returns include title, author, source, number of pages, and a link to an abstract, which then links to the full text. The format of full-text papers can vary considerably.
PubMedCentral http://www.pubmedcentral.nih.gov/ Users can view full text for free in PubMed Central, both as HTML documents through their Web browser and as downloadable PDFs. Features include links from article reference citations to PubMed abstracts, figures sized for on-screen viewing, and support for supplementary information such as data tables, streaming video, and high-resolution images. Coming soon in the next few months: direct links from PubMed search results to the full text of articles in PubMed Central, the development of new search engines, and flexible support for new scientific publishing models, such as "electronic-only" journals. With the backing of the U.S. National Institutes of Health, this represents a major and influential development in the rise of electronic media as a platform for scholarly communication.
SLAC SPIRES-HEP (Stanford Public Information Retrieval System — High Energy Physics) http://www-slac.slac.stanford.edu/find/spires.html Contains over 180,000 entries with full text from various other sites. Scope includes preprints, journal articles, theses, technical reports, and other documents.
Social Science Research Network http://www.ssrn.com/ A database of working papers in accounting, economics, finance, and law. This server will help users identify papers and authors. Some of the material is free, but the main strategy is to have users subscribe to various indexing and abstracting journals at $20 per journal, along with a $50 membership fee. The abstracting journals will link to the full text of the working papers.
Theoretical Ecology Preprint Database http://www.nceas.ucsb.edu:8504/esa/ppr/ppr.Query This server shows citations and abstracts and includes information on the status of the preprint (i.e., "in-press," "submitted," "published," or "unsubmitted"). A few links to full text.
Topology Atlas Preprints http://at.yorku.ca/topology/preprint.htm This site lists over 400 preprints and survey articles in topology. An abstract of each preprint and information about the source of the document is available. Most of these documents reside on the Topology Atlas server, but the server will classify and link to documents residing on any server.

Why were researchers (and their universities) actually willing to pay to maximize the accessibility of their research output by disseminating reprints? Harnad [2003] reported the need for maximizing university research impact through self-archiving and the requirement for institutional policies and computational tools designed to create and fill the university e-print archives as soon as possible, for until those archives are filled, research impact is being needlessly lost every day. Harnad advocated that universities need to adopt a self-archiving policy -- an extension of their existing "publish or perish" policy to "publish with maximal impact" and University libraries need to help with the first wave of self-archiving, doing "proxy" self-archiving for those researchers who feel too old, tired, or busy to do the few keystrokes per paper that are involved.

Brody et al. [2002] stated that, archives are becoming a network of texts rather than simply a classified collection of texts, commenting on citing, classifying, abstracting, listing and revising other texts. It emphasizes the definition of hypertext as multi-linear text, in contrast to the simple definition of a hypertext as 'a document with links in'. They have studied the most requested text types like is the full-text article, paratext elements

(title, abstract, keywords), archetexts (classification listings) or search requests. Download frequency, citing time etc have reported.

2.2 Current prospects and concerns about E-Print Archives

Kling and McKim [2000] stated that considerations of trust will continue to shape the kinds of scholarly communication that are seen as legitimate in a specific field. The divide between fields where researchers share unrefereed articles papers quite freely ("open flow fields") and those where peer reviewing creates a kind of chastity belt ("restricted flow fields") is likely to change slowly, if at all. Thus, for example, Ginsparg's unrefereed and (largely) unrestricted working article server includes some areas of physics, and a few cognate mathematical and chemical subfields (with relatively few mathematical articles posted). But it is expected that few biological or chemical specialities to join forces with this venture, and embrace it like high-energy physics or computer science. Even the field of physical chemistry had only a few papers posted in the first three months of 1999 (in contrast with experimental high-energy physics with nearly 100 submissions).

Paul Ginsparg [1994], concluded one of his very early article on arXiv with some unanswered questions to amplify some of his earlier comments:

- Who will ultimately be the prime beneficiaries - researchers, publishers, libraries, or other network-resource providers - of electronic research communication?
- What factors influence research communities in their rate and degree of acceptance of electronic technology, and what mechanisms are effective in facilitating such changes?
- What role will be played by the conventional peer-refereeing process in the electronic media, and how will it differ from field to field?
- What will be the role played by publishing companies, and how large will their profits be? If publication companies do adopt fully electronic distribution, will they pass along the reduced costs associated with the increased efficiency of production and distribution to their subscribers? Can publishing companies provide more value-added products than an unmanned automated system, the primary virtue of which is instant retransmission?
- What role will library systems play? Will information be channeled somehow through libraries, or directly to researchers?
- How will copyright law be applied to material that exists only in electronic form? At the moment publishing companies have "looked the other way" from these systems, living with the dissemination of the electronic preprint information as they did with the earlier preprinted form and claiming that it would be antithetical to their philosophy to impede dissemination of information. Will they continue to be so magnanimous when libraries begin to cancel journal subscriptions?
- What storage formats and network utilities are best suited for archiving and retrieving information? Currently arXiv uses a combination of e-mail,

anonymous FTP, and window-oriented utilities such as Gopher and World Wide Web combined with WAIS indexing to retrieve TeX and Post-script documents. Will something even better, such as Acrobat or some other format currently under development, soon merge with the above or emerge as a new standard?

- How will the medium itself evolve? Conservatively it can be imagined "interactive" journals in which equations can be manipulated, solved, or graphed; in which citations can instantly open references to the relevant page; and in which comments and errata dated and keyed to the relevant text can be inserted as electronic "post-it" notes in the margins.

Smith et al. [2003] reported the collaboration of Massachusetts Institute of Technology (MIT) Libraries and Hewlett-Packard Labs for the development of an open source system called DSpace and functions as a repository for the digital research and educational material produced by members of a research university or organization. Running such an institutionally-based, multidisciplinary repository is increasingly seen as a natural role for the libraries and archives of research and teaching organizations. As their constituents produce increasing amounts of original material in digital formats —much of which is never published by traditional means — the repository becomes vital to protect the significant assets of the institution and its faculty. The article describes the DSpace system including its functionality and design, and its approach to various problems in digital library and archives design with the implementation of DSpace at MIT, plans for federating the system, and issues of sustainability.

Journal article of Van de Sompel and Lagoze (2000) reported regarding the reason for launching the Open Archives Initiative is the belief that interoperability among archives is key to increasing their impact and establishing them as viable alternatives to the existing scholarly communication model. This conviction is expressed in the official mission statement of the initiative:

> The Open Archives initiative has been set up to create a forum to discuss and solve matters of interoperability between author self-archiving solutions (also commonly referred to as e-print systems), as a way to promote their global acceptance.

In July 1999, Paul Ginsparg, Rick Luce and Herbert Van de Sompel sent out a Call for Participation (Ginsparg, Luce, and Van de Sompel 1999a) to a meeting exploring cooperation among scholarly e-print archives. The meeting, held in October 1999 in Santa Fe, and originally called the Universal Preprint Service meeting, led to the establishment of the Open Archives initiative (OAI). The meeting was sponsored by the Council on Library and Information Resources (CLIR), the Digital Library Federation (DLF), the Scholarly Publishing & Academic Resources Coalition (SPARC), the Association of Research Libraries (ARL) and the Los Alamos National Laboratory (LANL). The participants were computer scientists and digital librarians. There were also representatives of existing and emerging e-print systems, of scholarly publishers and of the sponsors.

The central theme of the first meeting was the establishment of recommendations and mechanisms to facilitate cross-archive value-added services. Such services could combine information derived from cooperating archives, process that information to produce some value-added information, and make that enhanced information available to users, agents, or other services. Examples of such services include cross-archive search engines, current awareness services, linking systems, and peer-review services.

The Convention considered the following to be crucial components of an e-print archive:

- A submission mechanism;
- A long-term storage system;
- A management policy with regard to submission of documents and their preservation;
- An open machine interface, that enables third parties to collect data from the archive.

Hirtle [2001] differentiated the concepts OAI and OAIS. OAI stands for the Open Archives Initiative. OAI seeks to develop and promote interoperability standards to facilitate the efficient dissemination of content. Whereas the OAIS initiative arose from a need to ensure that scientific data would still be accessible in the future. OAIS is the draft ISO Reference Model for an Open Archival Information System. Developed by the Consultative Committee for Space Data Systems, the reference model has been of great interest to digital librarians and archivists beyond the space sciences. OAI grew from a desire to enhance access to e-print archives as a means of increasing the availability of scholarly communication. OAI is one of the most exciting developments in the area of information dissemination, and holds out the promise of radically changing how we access and use scholarly information.

The Open Citation Linking Project (OpCit) is a funded project, currently developing tools to make the existing resources more powerful by completely citation inter-linking all of the papers in The Los Alamos E-print Archive (arXiv) and eventually to extend this to all the rest of the disciplines in other open archives. The user need only click on the citation to view that paper -- as long as it too is archived online. The OpCit is making this resource still more powerful and useful for its current physicist users by connecting each paper to each paper it cites; this can be extended to all the rest of the disciplines in other open archives designed to be interoperable through compliance with the Santa Fe Convention. A citation-linked online digital corpus also allows powerful new forms of online informetric analysis that go far beyond static citation analysis, measuring researchers' usage of all phases of the literature, from pre-refereeing preprint to post-refereeing post-print, from download to citation, yielding an embryology of learned inquiry [see also http://www.eprints.org/results/report.html].

Three principal objectives elaborated by the OpCit project [Harnad et al., 1999] concern scale-compatibility-universality:

- Scale: to hyperlink each of the over 100 000 papers in Los Alamos's unique online physics archive to every other paper in the archive that it cites.
- Compatibility: to develop and integrate a family of generic linking tools and to design author and user interfaces to enable easy adoption by other archives.
- Universality: to promote the power of this remarkable new way of navigating the scientific journal literature and induce authors in other fields to create interlinked online archives like Los Alamos across disciplines and around the world.

Primary partners in the project were [Hitchcock et al., 2000]:

- Southampton University's Multimedia Research Group, with its expertise in linking applications, also home of the CogPrints eprint archive for cognitive sciences and a mirror site for the Los Alamos archives
- Cornell University, which is a major player building NCSTRL based on Dienst
- Paul Ginsparg from Los Alamos

Gadd [2003] presented the key findings of the RoMEO (Rights Metadata for Open archiving) Project, a one-year project of Information Systems Committee (JISC) with objectives to "explore the challenges associated with disclosure and sharing [of content], including IPR and the role of institutional repositories". RoMEO, which took place between 2002–2003, specifically looked at the self-archiving of academic research papers, and the subsequent disclosure and harvesting of metadata about those papers using the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) by OAI Data and Service Providers [“Open Archives Initiative”, 2002].

2.3 Use of and Citations to E-Print Archives

Physics/Astronomy librarian Gregory K. Youngen authored a report that tracked citations to electronic preprints by traditional scholarly science journals. Youngen observed that the number of electronically posted preprints in astrophysics doubled every year during the 1992 through 1997 study period. Using the Institute for Scientific Information’s SciSearch, slightly over 100 citations to preprints were retrieved in 1995; in 1997, the number of citations to electronic preprints rose to over 400. Youngen concluded, “The growth rate in citations reflects not only the authors’ acceptance of the e-print, but the publishers and editors [acceptance] of the manuscripts as well” [Youngen, 1998].

The advent of the Web has brought dramatic growth in the availability of journal papers online, many free of charge through services such as arXiv, and has opened new possibilities for citation analysis. With network access to works, it becomes possible to automate data collection from very large resources at relatively low cost, making it feasible for Web-based citation services to be offered free to users. NEC's ResearchIndex [Lawrence et al., 1999], CERN's Document Server [Claivaz et al. 2001] and Citebase, a citation and impact-ranked search service produced by the Open Citation Project, are examples. In contrast to ISI's established subscription services covering a self-selecting corpus of 6500 of the highest impact journals, ResearchIndex and Citebase are in their infancy, covering diverse collections, having to work with inconsistent data formats, and

trying to identify user preferences to optimise their features. ResearchIndex [NEC ResearchIndex] currently indexes over a million computer science papers.

Harnad and Carr [2000] reported a study on the file formats in which researchers downloaded the LANL e-print archives. The highlights were Ps (72.40 %); Source (9.17%); pdf (9.14%); TeX (8.37%); Dvi (0.69%); and html (0.23%). Distribution of hits of different links like paper downloads, Picture downloads Abstract downloads, browsing for new additions, etc. were also graphically presented.

Brown [2001] emphasized the growing importance of e-prints in the scholarly communication of physics and astronomy. This was especially shown to be the case for the area of high-energy particle physics. Brown has introduced citation rate, a measure for rating the citation pattern of e-print archives. Citation rate has calculated as the ratio of the number of citations to the e-prints occurring in a given time period to the total number of e-prints appearing in the archives. The citation rate is expressed as a percentage. Citation analysis was performed on e-prints from the Los Alamos e-print archive, arXiv.org, using the Stanford Public Information Retrieval System's High Energy Physics (SPIRES-HEP) and the Institute for Scientific Information's SciSearch databases. The SPIRES-HEP data represents citations to e-prints by e-prints while SciSearch data represents citations to e-prints by journal articles. Citations from 1991 to 1999 were examined. E-prints in the SPIRES-HEP database were cited approximately 10 times each by other e-prints, while those found in SciSearch were cited approximately 0.5 times each by journal articles. Despite this difference, the citation patterns were similar for both e-prints and journal articles. The citation rate by both e-prints and journals was highest from the high-energy particle physics archives. The data from SPIRES-HEP indicates that e-prints are used to a greater extent by physicists than previously measured and that e-prints have become an integral and valid component of the literature of physics. Citations to e-prints by journal articles were exhibited by these studies to have grown over the past decade, but the present study shows that their real significance is anchored in the routine use of the SPIRES-HEP database. The data illustrate that e-prints are being cited with increasing frequency by a variety of journals in a wide range of physics and astronomy fields, the High Energy Physics Archives; hep-ex, hep-lat, and hep-th, being the most highly cited archives studied. Although the number, the usage, and the citations to e-prints in arXiv.org are increasing with time, the citation rates lag behind this wave to some degree. In this investigation, the e-prints from 1997 and 1996 were found to have been cited at the highest rate.

Luce [2001] has given an account of usage statistics of arXiv e-print archives. He has reported that arXiv attracted from 110,00 to 130,000 visits daily. This study by Lawal [2002] surveyed a randomly chosen sample from a population of 240,000 scholars in nine scientific disciplines from private and public colleges and universities across the United States and Canada. The disciplines included physics/astronomy, chemistry, mathematics/computer science, engineering, cognitive science/psychology, and biological sciences. The survey sought to determine use and non-use of e-print archives in the different disciplines. Results show that 18 percent of the researchers use at least one archive while 82 percent do not use any. Scholars in physics use e-print archives the

most and chemistry the least. ArXiv receives the most use and authors' web sites the least use. Reasons for use include dissemination of research results, visibility, and exposure of authors. Reasons for non-use include publishers' policies and technology constraints. Lawal concludes his article with the remark that not all the disciplines are up to speed with using e-print archives partly due to the culture of information use in the various disciplines and partly due to low awareness level. Self- archiving initiatives might gain ground as every discipline becomes aware of the potential value for rapid and wider exchange of scientific information, fostering scholarly communication.

Paul Ginsparg [1994] has presented some statistics on the usage of arXiv from August 1991 to April 1994 along with a graphical representation of daily summary of www access to http://www.xxx.lanl.gov/ (old site address of http://www.arxiv.org/) from January to May, 1994.

2.4 High-Energy Physics E-Print Archives

High-energy physicists began to disseminate their research to colleagues in the form of paper 'pre'– prints long before they acquired or developed the tools to disseminate these pre–prints to each other electronically [Addis, 1971]. They shared these research papers in advance of the paper's formal publication in the scholarly literature for several reasons. One of the first purposes was to circulate a draft of the paper amongst many collaborators who were joint authors. A second motive was to circumvent increasingly lengthy journal publication schedules, which were causing delay times of up to two years between submission and publication. Theoreticians in this field publish relatively frequently. Their papers sometimes function as iterative discussions – provoking lively dialog both within their subfield and between them and experimentalists. Both at its inception and its conclusion, an experiment would be severely hampered by the long lead times of traditional scholarly journals. For experimentalists contemplating a particular research question, not knowing that another team was already engaged in a similar problem could prove expensively duplicative. And, when years of effort culminate in a publication that may radically alter the fundamental explanations of our universe, experimentalists are understandably reluctant to passively sit out a one to two year publication cycle before their results appear in print.

Researchers in this heavily computer-dependent field are, of necessity, extremely computer literate. Because their field is highly specialised and abstract, high-energy physicists have often written their own software and invented new computing programs and tools themselves. Newcomers to the field quickly develop a high level of computer literacy and a great deal of expertise – and faith – in using computing systems to do work faster and better. It is not surprising that these characteristics of computer literacy, networked communication, and international collaboration also created a demand for rapid, comprehensive, and widely accessible control of high-energy physics literature.

Goldschmidt-Clermont [2002] elaborated some communication techniques (ideas in the 1960s) prevalent to high-energy physics in order of increasing elaboration and synthesis, communication techniques and their respective functions, and scientists' participation in

the operation of the communication network. High-energy physicists have developed a variety of techniques to fulfill the functions of communication. In first approximation, these techniques meet the goals they have been assigned. But not all the goals have yet been fully recognised and met. Scientific societies, national bodies, educational institutions are aware of the need for effective communications and are supporting vigorous research programs that will undoubtedly produce further improvements in information handling and retrieval techniques. These improvements will more probably bear on publications, i.e. on communication channels in the upper half of the elaboration ladder, rather than on specialised current-awareness material of hot interest to high-energy physicists, but to them only.

As early as the 1960s, the number of preprints in High-Energy Physics (HEP) had become large, and ways were being sought to deal with the resulting problems and inequities [Addis et al., 1970]. As noted above, in March 1965, Moravcsik [1965] proposed the establishment of a central registry of preprints in particle physics, soon followed by the more ambitious plan for Physics Information Exchange (PIE). PIE would be analogous to an Information Exchange Group (IEG), initially only in theoretical HEP. Moravcsik's [1988] interest in preprints as an important form of communication was a continuing one, in part because of his desire to foster communication with scientists in resource-poor countries.

Like the IEG experiment, the PIE proposal generated controversy [Pasternack, 1966; “Editorial’, 1966]. For example, Simon Pasternack, editor of the major journal *Physical Review*, was concerned that journals would have only a secondary role in the scheme of physics communication. An editorial critical of PIE, published in *Nature* [“Editorial’, 1966], expressed concerns about the 'clubbiness' of existing preprint networks, about the difficulties involved in recognizing and controlling plagiarism, and about an apparent insensitivity to 'those qualities which distinguish good literature from bad'. The editorial concluded with the hope that 'PIE will be stillborn'.

The US Atomic Energy Commission (AEC) subsequently financed a study by the American Institute of Physics to examine the feasibility and desirability of PIE. One of the conclusions of the report of this study, issued in August 1967, was that the first phase of such an experiment should involve a weekly preprint announcement service for high energy physicists, to be operated for 6 months [Addis et al., 1970]. In April 1968, the newly formed Division of Particles and Fields of the American Physical Society (APS) agreed to sponsor a preprint accession list. This list would permit currently available and relevant theoretical and experimental preprints to be announced, but would avoid the expensive central dissemination of all preprints. The preprint list would be a more cost-effective approach to preprint distribution because, in the early 1970s, only 20-30% of preprints were ever requested by anyone, and only about 3-5% were regarded as 'winners' [Kirk, 1977]. The preprint list would also allow control of the actual distribution of preprints to remain where it had traditionally been, with the authors who received requests for preprints and their host institutions.

The result of these plans to develop a pre-print announcement service was 'Preprints in Particles and Fields' (PPF), which began weekly publication at the Stanford Linear Accelerator Center (SLAC) in January 1969. It received financial support from the AEC Division of Technical Information for an experimental 18-month period [Addis et al., 1970]. The further contributions of the PPF to the establishment of a preprint culture in HEP, and its subsequent transformation into an e-preprint culture, have been described in some detail by authors familiar with the history of the SLAC Library [Addis et al., 1970; Addis, Unpublished; Kreitz, 1996; O'Connell, 2000].

For example, in a brief history of the SLAC Library, Addis [Unpublished] identified a number of important events. An initial one was the decision in 1962 by SLAC's first director, W. H. K. Panofsky, to acquire and catalogue preprints in HEP. A second, after 1969, was the willingness of hundreds of physicists to pay an annual subscription fee to get PPF weekly by airmail. A third was the establishment of a PPF section called 'Anti-preprints', which recorded the preprints that subsequently were published in journals. This list is especially noteworthy because it was popular with journal editors, who could match references to preprints with the published article [Addis, Unpublished; O'Connell, 2000].

An example of another noteworthy event identified by Addis [[Unpublished] was the development, in 1979, of a new text formatting system called TeX. This system provided a way for authors to produce high quality mathematical text (including physics notation) that could easily be widely distributed via email. Then, in August 1991, Paul Ginsparg (a theoretical physicist) started the first e-preprint archive, at hep-th@arXiv.org, and invited fellow string theorists to deposit the TeX source for their new preprints by email. New preprints were announced and distributed via email. By 1994, features of the World Wide Web (WWW) had been exploited to provide more convenient access to e-preprints, and use of the WWW had expanded to the world beyond physics [Addis, Unpublished].

Why were the earliest adopters of an e-preprint culture those in theoretical HEP? It has been noted that theoreticians in HEP publish relatively frequently, and that their papers sometimes function as iterative discussions, with each other and with experimentalists [Kreitz, 1996]. They want to stay up to date on one another's research [Youngen, 1998; Langer, 2000]. However, perhaps the most concise summary of the multiple factors involved has been Ginsparg's [1996]. The HEP physicists have been members of a well-defined and highly interactive community of voracious readers, with a pre-existing hard-copy preprint habit, a standardized text formatting system (TeX), and a generally high degree of computer literacy. They also have had little concern about patentable content, and have preferred to assign intellectual priority at the point of dissemination, rather than after peer review [Ginsparg, 1996]. The most crucial factor may have been the extent to which the author, reader, and reviewer communities have coincided [Ginsparg, 1996], and thus have had an implicit agreement (or 'scholarly consensus' [Hargens, 1988]) about standards of quality for research considered to be acceptable for publication.

The finding that the reliance on e-prints by scientists in other fields of physics was not as great leads to the question of why high-energy particle physicists are more apt to use

e-prints than are other physicists. Other scientists, most notably those in the life sciences, are concerned with the lack of quality control in e-prints as compared to peer reviewed publication [Butler, 1999; Delamothe et al., 1999; "EMBO", 1999; Glaze, 1999; Marshall, 1999a, 1999b; "Would you use", 1999].

Kreitz [1999] has expressed his ideas on the effect of new systems of electronic information storage and delivery on libraries is most dramatic in the field, which invented the Web, high-energy physics. The experiences of high-energy physics libraries over the past four years show the pivotal role libraries can play in creating a comprehensive electronic research environment.

Peek [2000] has raised the questions of time stamping, authentication, protection of intellectual property, version control, and archiving. Peek reports the emergence of publisher based preprint servers like The Chemistry Preprint Server (CPS), a pre-print server at ChemWeb, Inc., a wholly owned subsidiary of Elsevier Science, Ltd.; e-print servers at John Wiley & Sons' InterScience site etc. due to the pressure on them caused by the alternative forms of circulating scholarship. Peek has also mentioned Eprints.org software developed by Electronics and Computer Science Department at the University of Southampton available from http://www.eprints.org/ for building e-print archive repositories quickly and easily with a web interface for managing, submitting, discovering, and downloading documents. This generic version is fully interoperable with other open archives, according to the agreement reached at the October 1999 Open Archives initiative meeting in Santa Fe, New Mexico (http://www.openarchives.org). Ed Sponsler and Van de Velde [2001] has reviewed this software in terms of its setup, configuration, administration, user features, and overall evaluation.

3. OBJECTIVES

Objectives of the present study were to:

3.1 highlight **High Energy Physics - Experiment** (hep-ex) E-Print Archives with reference to:

- 3.1.1 Growth of Citations
- 3.1.2 Frequency of Citations
- 3.1.3 Highly Cited E-Print Archives
- 3.1.4 Highly Citing Sources
- 3.1.5 Highly Citing Authors and Lotka's Law Applied to Information Use
- 3.1.6 Analysis of the Countries in the Affiliation of Citing Authors

3.2 highlight **High Energy Physics - Lattice** (hep-lat) E-Print Archives with reference to:

- 3.2.1 Growth of Citations
- 3.2.2 Frequency of Citations
- 3.2.3 Highly Cited E-Print Archives
- 3.2.4 Highly Citing Sources
- 3.2.5 Highly Citing Authors and Lotka's Law Applied to Information Use
- 3.2.6 Analysis of the Countries in the Affiliation of Citing Authors

3.3 highlight **High Energy Physics - Phenomenology** (hep-ph) E-Print Archives with reference to:

- 3.3.1 Growth of Citations
- 3.3.2 Frequency of Citations
- 3.3.3 Highly Cited E-Print Archives
- 3.3.4 Highly Citing Sources
- 3.3.5 Highly Citing Authors and Lotka's Law Applied to Information Use
- 3.3.6 Analysis of the Countries in the Affiliation of Citing Authors

3.4 highlight **High Energy Physics - Theory** (hep-th) E-Print Archives with reference to:

- 3.4.1 Growth of Citations
- 3.4.2 Frequency of Citations
- 3.4.3 Highly Cited E-Print Archives
- 3.4.4 Highly Citing Sources
- 3.4.5 Highly Citing Authors and Lotka's Law Applied to Information Use
- 3.4.6 Analysis of the Countries in the Affiliation of Citing Authors

3.5 an inter-comparison of four categories of LANL high-energy physics e-print archives in terms of number of submissions, citations received, Lorenz Curves,

Gini's Coefficient, and citing journals, citing authors and countries in the affiliation of citing authors, and Lotka's Law applied to information use and sociology of information.

4. MATERIALS AND METHODS

The site http://www.arxiv.org/ has been used for the submission details of the high energy physics - experiment (hep-ex), high energy physics - lattice (hep-lat), high energy physics - phenomenology (hep-ph), and high energy physics - theory (hep-th) e-print archives of Los Alamos National Laboratory (LANL). The home page of the site is looked like in Figure 1 as on June 2004.

The *Science Citation Index* (1991-2002) has been used for the citations received for the e-print archives of the above-mentioned four categories of high-energy physics. The *Science Citation Index* is a multidisciplinary database of journal literature of the sciences, published by Institute of Scientific Information, Philadelphia. *The Science Citation Index Compact Disc Edition* (SCI CDE) covers over 3,300 of the world's most significant scientific and technical journals across more than 160 scientific disciplines, with over 700,000 new items indexed each year.

The *SCI CDE* with Abstracts database is updated monthly, while the *SCI CDE* without abstracts is updated every three months. Each cumulate to an annual disc. All ISI CD Edition databases include indexing of every article and significant item -- including letters, reviews, corrections, and editorial material -- in every fully covered publication.

The products can be used as conventional author-subject indexes (fields to be searched are shown in figure 1), but what makes them unique is the indexing of cited references of articles covered. The advantage of this indexing is:

Searching by cited author or cited paper: Cited reference searching enables you to search forward in time--to take a known, relevant paper and uncover other, later papers that cite it. Cited reference searches allow you to uncover essential information that cannot be retrieved through traditional search techniques.

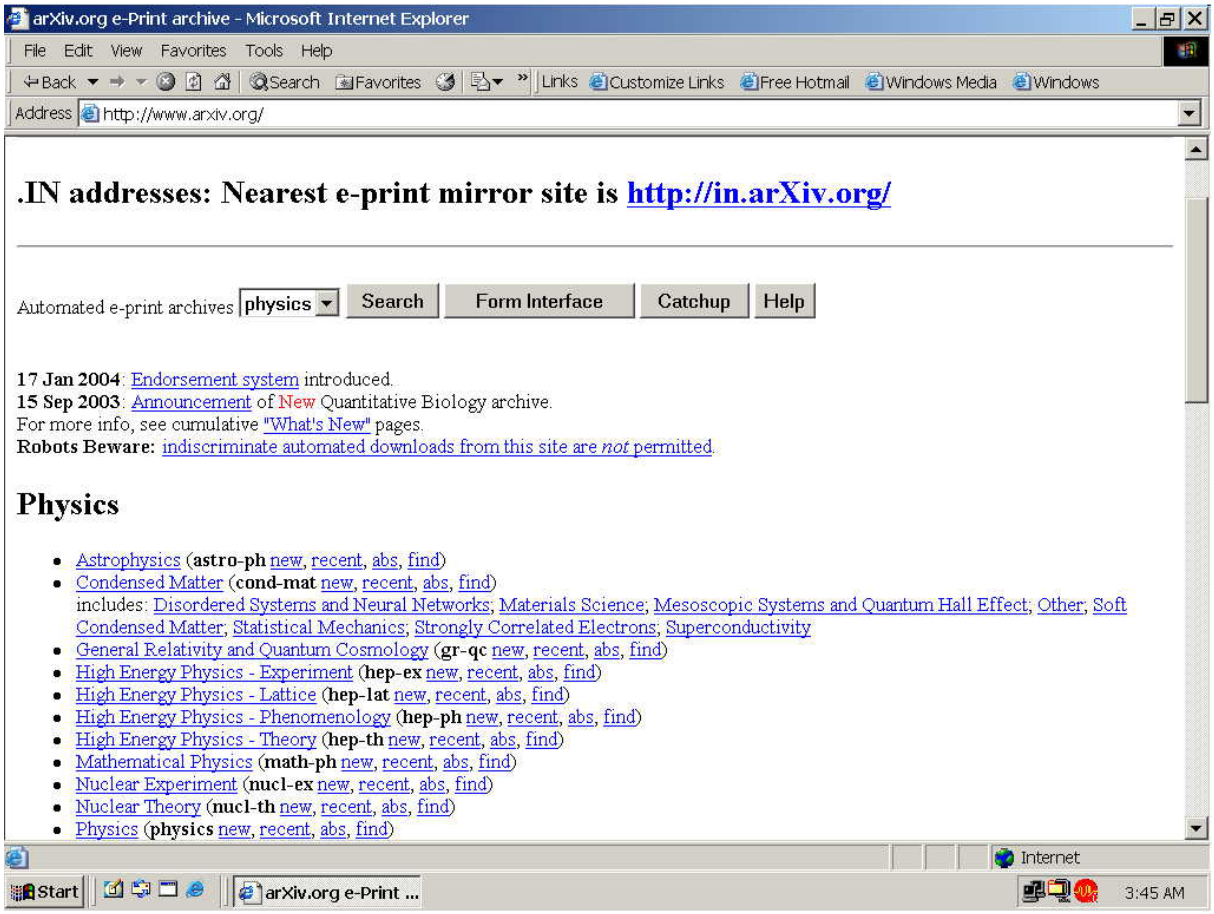

Figure 1: Home page of LANL e-print archives available at http://www.arxiv.org/

The cited reference field in *Science Citation Index* has the following common format (Figure 2):

<FIRST AUTHORS NAME-INITIAL>-<PUBLISHED YEAR>-<ABBREVIATED FORM OF SOURCE>-<VOLUME NO. IF ANY>-<FIRST PAGE NUMBER>

Example: MAN-CK-1994-RADIAT-PROT-DOSIM-V55-P219, here 'MAN-CK' is the name of the first author, '1994' is the year of publication, 'RADIAT-PROT-DOSIM' is the abbreviated form of the journal *Radiation Protection Dosimetry* and 'V55-P219' for the volume number '55' and first page number '219'.

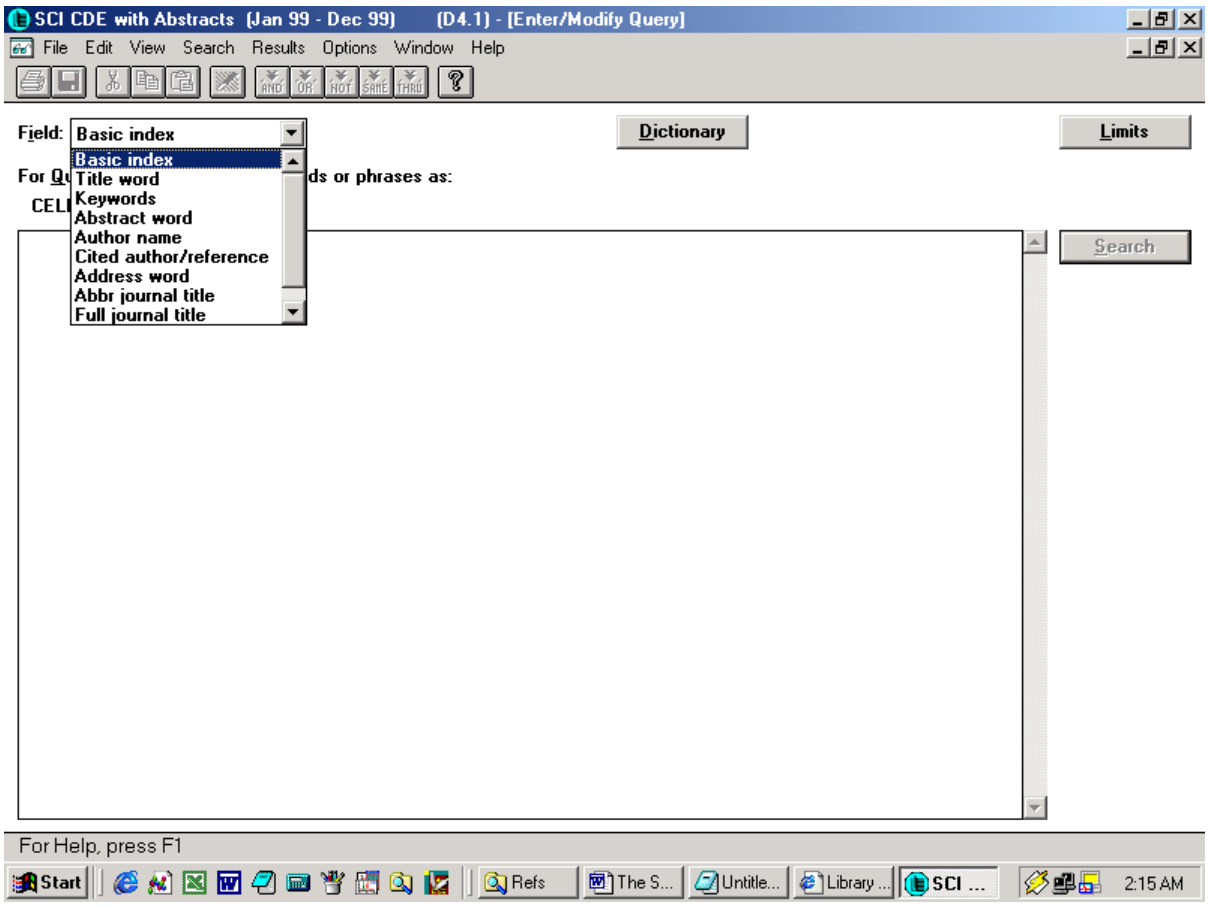

Figure 2: Search interface of *Science Citation Index*, where fields can be searched are given

This study has used *Science Citation Index* for getting the number of citations to e-print archives for the years 1992-2002.

The e-print archive number assigned by the LANL preprint server provides a standardized common number for preprints that allows the item to be uniquely identified by the users (author/s, staff of LANL, free land peer reviewers, information analysts etc.). LANL's alpha-numeric code provides broad subject categorization, year indicator, and accession number [Youngen, 1998]. A typical example of e-print archive number is:

gr-qc/9911092

where 'gr-qc' stands for General Relativity/Quantum Cosmology, '99' for the posted year 1999 and '11092' for the accession number.

The e-print archive numbers are 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 [Prakasan et al., 2003].

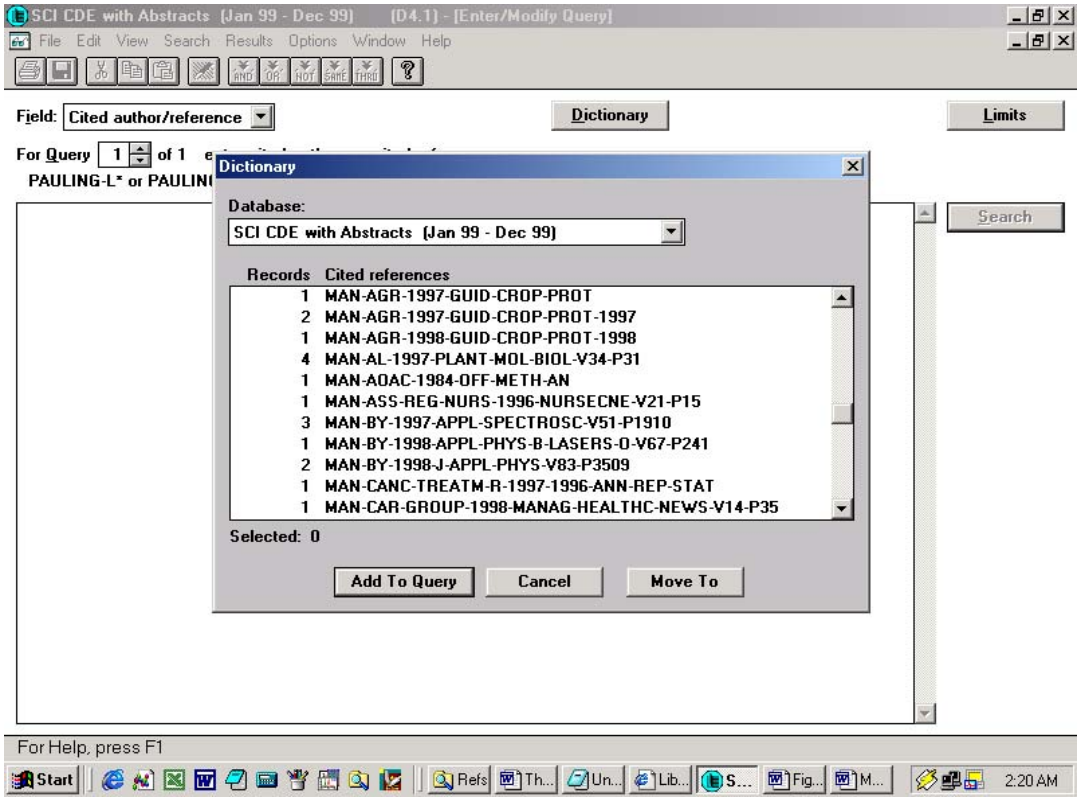

Figure 3: Format of Cited Reference field of *Science Citation Index*

Even though *Science Citation Index* is not following any consistency in inputting the cited reference for e-print archives (evident from the close observation to the entries of e-print archives), the common citing style of LANL e-print archives is as follows:

<FIRST AUTHORS NAME-INITIAL>-<0000>-<SHORT FORM OF LANL CATEGORY>-<NUMBER>

Example: NATH-P-0000-HEPPH9701301, here NATH-P is name of the first author of the e-print archive hep-ph/9701301 and '0000' is the common usage for e-print archives.

The queries are formed in a different way, as *Science Citation Index* does not provide searching through the sources in the cited reference. Also *Science Citation Index* does not allow wild characters at both the ends. For example if some body would like to search the citations to a particular journal, the following search query has to be performed.

<INITIAL LETTER>*<SOURCE NAME IN ABBREVIATED FORM IN ALL COMBINATIONS>*

In this case the search software will search only records with citations to the journal with the authors name starting with the initial letter. Here initial letter is compulsory. So if the

person would like to search for the number of citations to a particular journal should go for all letters from 'A' to 'Z', 0 to 9 and one more for <ANON> (for unknown authors name). The queries developed can be combined and make a single query using the Boolean Operator 'OR'. The search query developed is shown in Figure 3 for the occurrence of 'HEPEX' in cited references.

Similarly, the study has taken care another possibility of occurrence like 'HEP-EX' in cited references (Figure 4).

Among the records retrieved, the records, which contain the string 'HEP-EX' as a part of another source (for example, string 'HEP-EX' is occurring as a part of some journals), are removed. The 'find' option LANL site has used to make out or confirm some e-print archive numbers, where some minor discrepancies were there. See the record for example:

Wrong Entry: ITOW-Y-0000-HEPEX**100**6019

Correct entry: ITOW-Y-0000-HEPEX**010**6019

Still there were some records, which could not be identified. The Table 1 shows the distribution of records in the four high-energy physics categories.

The final correct records are analysed for each category of high-energy physics separately for the year-wise growth, extend of citations, highly cited e-print archives, highly citing sources, and highly citing authors.

Table 2: Distribution of records of and citations to the four high-energy physics categories of e-print archives of LANL (1991-2002) in *Science Citation Index* (1991-2002)

HEP Archives	**Total records in *SCI***	**Total citations**	**Incorrect & unidentified**	**Total considered**
hep-ex	2584	3996	8	3988
hep-lat	2691	5845	39	5806
hep-ph	14773	44342	46	44296
hep-th	13976	64325	256	64069
Total	34024	118509	348	118161

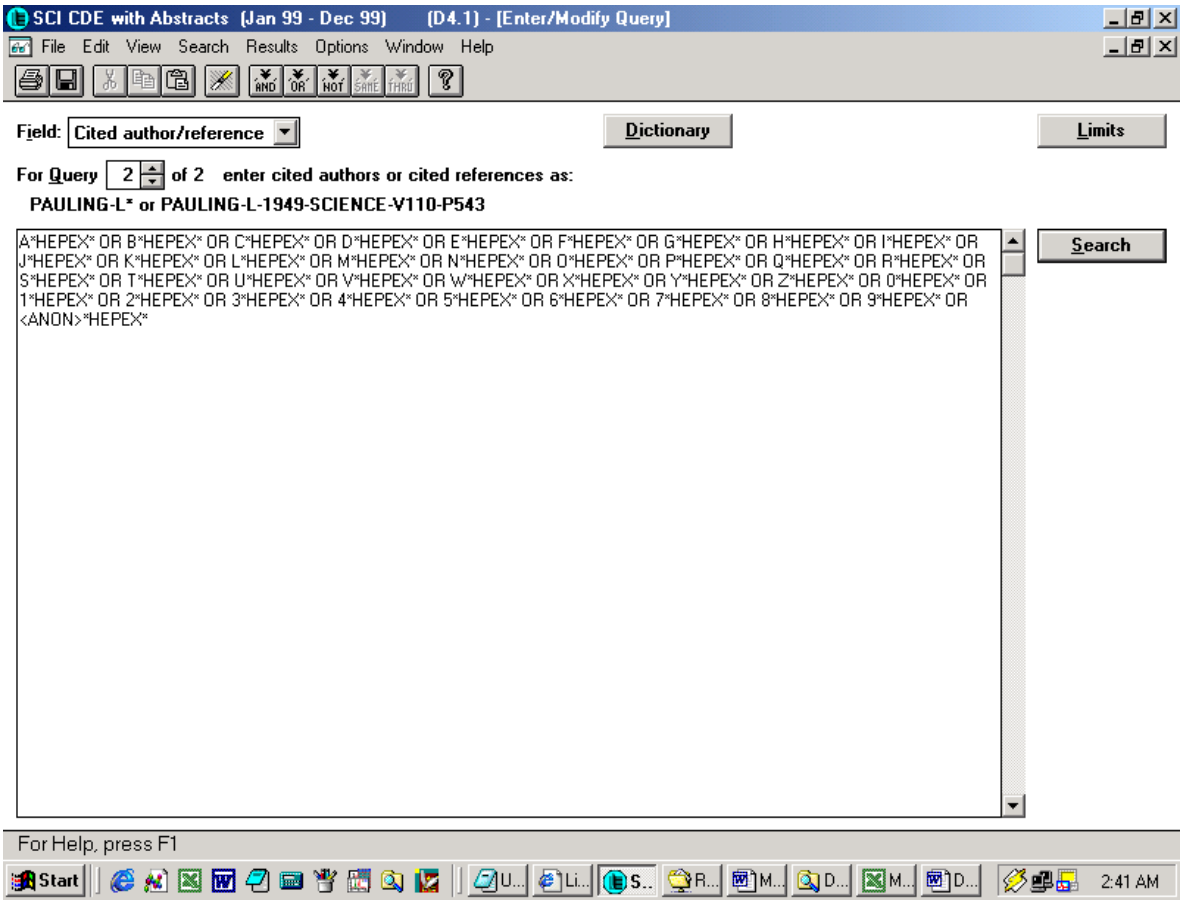

Figure 4: Search query applied for retrieving records, which cited the 'hep-ex' e-print archives with the string 'HEPEX' in cited reference field of *SCI*

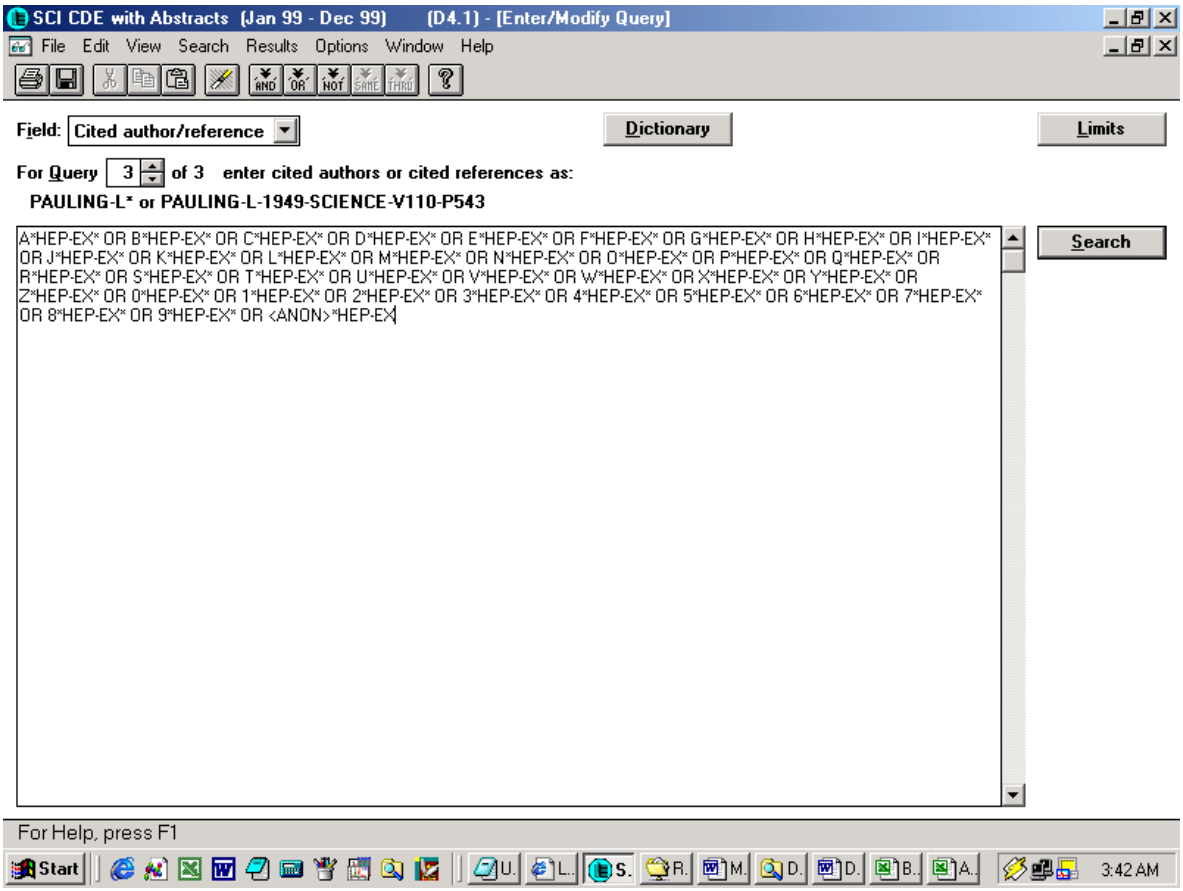

Figure 5: Search query applied for retrieving records, which cited the 'hep-ex' e-print archives with the string 'HEP-EX' in cited reference field of *SCI*

Immediacy impact for e-print archives has been defined as the ratio of the number of citations received in the same year of the submission with the total number of citations.

Lorenz curve is a graphic method of studying the dispersion. It was first used by Max O. Lorenz, an economic statistician for the measurement of economic inequalities such as in the distribution of income and wealth between different countries or between different periods of time. Lorenz curve is also used in business to study the disparities of the distribution of wages, turnover, production, population etc.

Lorenz curve is drawn with reference to the cumulated percentage of the variable and the frequency. Frequency cumulated percentage values are taken along the x-axis and the variable cumulated percentage values are taken along the y-axis. A diagonal line is drawn joining the points (0,0) and (100, 100). The Lorenz curve is curved away from the line of equal distribution.

Economists are very often interested in the distribution of income, wealth etc. It is also of interest to know how far such a distribution departs from one of equality. Lorenz Curve gives an idea about the degree of inequality of income or wealth of a group of people. The Lorenz curve can be used to study the inequality of income or wealth in a country and sometimes to make comparisons between countries or between different time periods.

Gini has devised a concentration ratio (called Gini's Coefficient) based on his mean difference measure. Coefficient of concentration is obtained by dividing the mean difference by twice the arithmetic mean [Potti].

Gini's Coefficient, $G = \frac{MeanDifference}{2\bar{x}}$,

Where *Mean Difference* = $\frac{\sum x_i - \bar{x}}{n}$, and

n=number of observations

This value lies between 0 and 1. In equal distribution its value is zero with the increase in the inequality, the value of coefficient goes up.

The idea of Lorenz Curve has drawn into the study for analysing the citations received to the high-energy physics e-print archives. In this case, the citations received are treated as the income to each and every e-print archives.

According to Lotka's Inverse Square Law of Scientific Productivity there exists a correlation between the authors of scientific papers and their number of contributions [Deokattey, 2001]. It states that the number of authors making n contributions is about $1/n^2$ of those making one contribution. Mathematically it stands as

$$n_i = n1/i^{\alpha}, \text{ where } i=1,2,3,\ldots i_{max} \text{ and } \alpha=2$$

5. RESULTS AND DISCUSSIONS

5.1 High Energy Physics - Experiment (hep-ex) E-Print Archives

The 'hep-ex' e-print archives of LANL are for preprints in high-energy experimental physics started from April 15, 1994 (http://www.arxiv.org/list/hep-ex/info). There were a total of 4142 e-prints are added to this category till 2002. A steady growth can be observed in the number of submissions in each year to the e-print archives in this category. The following sections discuss the growth of citations to the 'hep-ex' e-print archives, frequency of citations, sources citing, and citing authors and countries in the affiliation of the citing authors as per *Science Citation Index* (1991-2002).

5.1.1 Growth of Citations

Among the total of 4142 e-print archives submitted to the 'hep-ex' category, 1296 e-prints (31.29%) have cited at least once as per *Science Citation Index* (1991-2002). On an average of 27.94 % of e-print archives in the category are cited per year at least once. The trend of citedness versus the number of submissions from 1994 to 2002 is presented in Figure 6.

5.1.2 Frequency of Citations

The extent of citation in terms of repeated citing of an individual e-print archive shows its importance to the researchers as any other type of research works like peer-reviewed journal articles, conference papers, reports etc. Citation frequency is a measure of research activity, or of communication about research activity. Citation frequency reveals the impact of a particular publication or scientist [Garfield, 1973]. The citations to each e-print archives have been assumed as the quantitative measurement of quality of e-print archives. When the citing frequency is considered as the income of the e-print archives, the Lorenz Curve for the same phenomena is depicted in Figure 7. The Gini's Coefficient is found as 0.62 in case of the 'hep-ex' e-print archives.

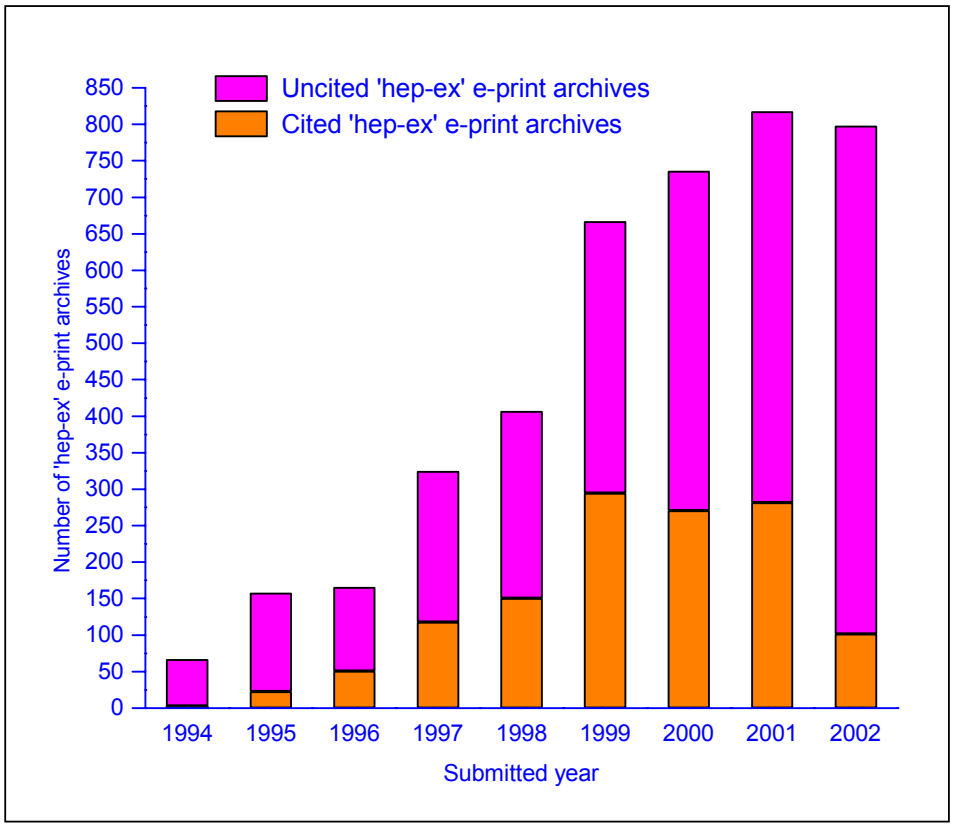

Figure 6: Number of the 'hep-ex' e-print archives of LANL (1994-2002) cited at least once and uncited as per *Science Citation Index* (1991 – 2002)

5.1.3 Highly Cited E-Print Archives

The average number of citations to the individual the 'hep-ex' e-print archives of LANL (1994-2002) was 3.08 as per *Science Citation Index* (1991–2002). Table 3 gives a list of ten highly cited 'hep-ex' e-print archives with the name of author(s), title, comments, published sources etc. The citations received to these e-print archives as per *Science Citation Index* (1991 – 2002) if they are published in a formal source are also documented. Figure 8 depicts the year-wise citing pattern of top ten highly cited e-print archives. On an average 94.36 % of the citations to these ten e-print archives are received with in two years after the submission. High immediacy impact was observed for 'hep-ex/0102017'. No immediacy impact was observed for the e-print archive 'hep-ex/0008064' but it had high citations during next two years after its submission year. Highest citations received by 'hep-ex/0105023' in the immediate next year after its submission.

Table 3: Highly cited ten 'hep-ex' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

E-Print archive	Title, Author(s), Comments, Published source etc.	Citations received		
		Before publishing	After publishing	Total
hep-ex/9807003	Evidence for oscillation of atmospheric neutrinos Authors: The Super-Kamiokande Collaboration, Y. Fukuda et al Comments: 9 pages (two-column) with 4 figures. Small corrections to Eqn.4 and Fig.3. Final version to appear in PRL Report-no: ICRR-Report-422-98-18,BUHEP-98-17,UCI-98-8,KEK preprint 98-95,LSU-HEPA-5-98,UMD-98-003,SBHEP98-5,TKU-PAP-98-06,TIT-HPE-98-09,CSUDH-HE P-98-04 Journal-ref: Phys.Rev.Lett. 81 (1998) 1562-1567	47	1041	1088
hep-ex/9805006	Study of the atmospheric neutrino flux in the multi-GeV energy range Authors: The Super-Kamiokande Collaboration: Y. Fukuda et al Comments: 14 pages with 6 figures, minor changes for publication Report-no: ICRR-Report-418-98-14, CSUDH-HEP 98-03, KEK Preprint 98-41, LSU-HEPA-3-98, SBHEP98-3, NGTHEP. 98-03, OULNS 98-02, TKU-PAP-98-03, TIT-HPE-98-06, UWSEA PUB 98-03 Journal-ref: Phys.Lett. B436 (1998) 33-41	46	316	362
hep-ex/0102017	Precise Measurement of the Positive Muon Anomalous Magnetic Moment Authors: H.N. Brown, et al, Muon g-2 Collaboration Comments: 5 pages and 5 figures. Submitted to Physical Review Letters Journal-ref: Phys.Rev.Lett. 86 (2001) 2227-2231	35	209	244
hep-ex/9907037	Limits on Neutrino Oscillations from the CHOOZ Experiment Authors: M. Apollonio, A. Baldini, C. Bemporad, et al. Comments: 19 pages, 11 figures, Latex file Journal-ref: Phys.Lett. B466 (1999) 415-430	38	193	231
hep-ex/9711002	Initial Results from the CHOOZ Long Baseline Reactor Neutrino Oscillation Experiment Authors: The CHOOZ collaboration (M. Appollonia et al.) Comments: 13 pages, Latex, submitted to Physics Letters B Journal-ref: Phys.Lett. B420 (1998) 397-404	43	52	95
hep-ex/9908022	$b\to s\gamma$ Branching Fraction and CP Asymmetry Author: S. Ahmed, et al, CLEO Collaboration Comments: 9 pages postscript, also available through this http URL, Report-no: CLEO CONF 99-10	48	39	87
hep-ex/0008064	Physics at a Neutrino Factory Authors: C. Albright, G. Anderson, V. Barger, et al. Report-no: Fermilab-fn-692	61	13	74
hep-ex/9905016	Atmospheric Neutrinos at Super-Kamiokande Authors: K. Scholberg, for the Super-Kamiokande Collaboration Comments: Talk presented at 8th International Workshop on Neutrino Telescopes, Venice, February 23-26 1999	49	19	68
hep-ex/0105023	Super-Kamiokande atmospheric neutrino results Authors: Toshiyuki Toshito, the Super-Kamiokande collaboration Comments: 8 pages, 4 figures, to be published in the proceedings of XXXVIth Rencontres de Moriond Electroweak Interactions and Unified Theories	51	10	61
hep-ex/9903034	Solar Neutrinos with Super-Kamiokande Authors: Michael B Smy (University of California, Irvine, Super-Kamiokande) Comments: 7 pages, 6 figures, LaTeX 2, RevTeX. 11 EPS files included using epsf style. This is part of the proceedings for the DPF'99 Conference	39	11	50

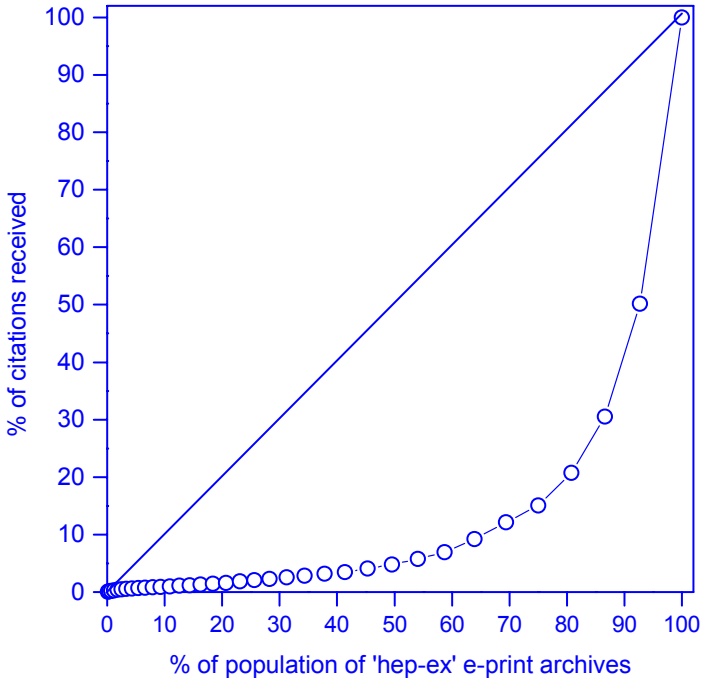

Figure 7: Lorenz curve showing the distribution of citations received to the 'hep-ex' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

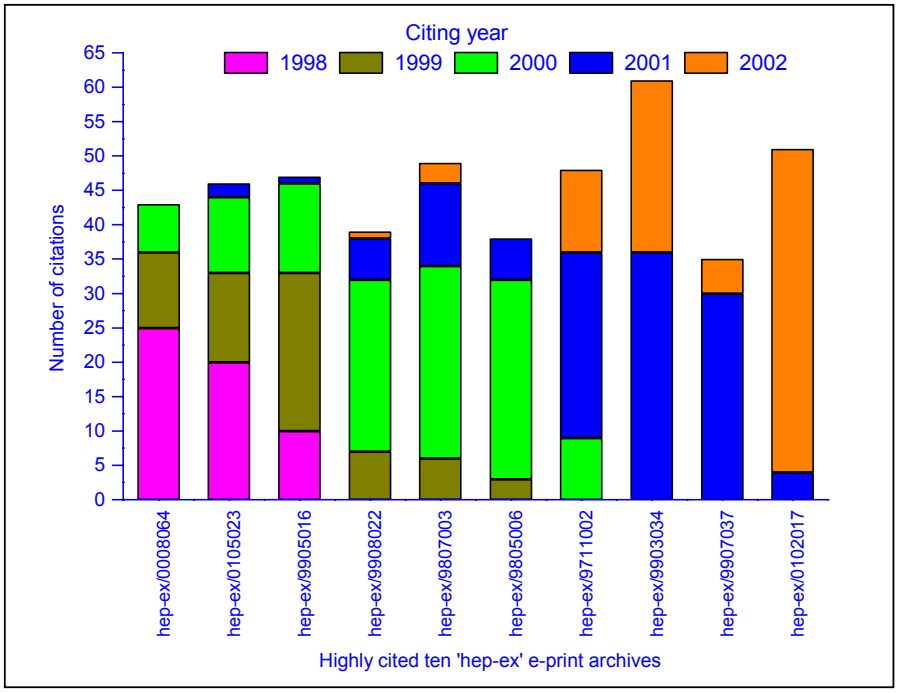

Figure 8: Citing pattern of highly cited ten 'hep-ex' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

5.1.4 Highly Citing Sources

The sources citing the 'hep-ex' e-print archives are all journal articles. The total number of journals citing the 'hep-ex' e-print archives as per *Science Citation Index* (1991-2002) was 82. Table 4 lists the journals with the number of times cited, and the corresponding Impact Factors. In case an article is citing more than one e-print archives, then also the number of times cited by the journal is counted as one. The average Impact Factor (IF) of these journals is 2.59 (Impact Factors of five journals could not be identified). The Impact Factors and number of times cited the e-print archives in these journals are depicted in Figure 9. Lot of fluctuation was observed.

The five journals, which are citing frequently the'hep-ex' e-print archives are *Physics Letters B* (550 times cited) followed by *Physical Review D* (527 times cited), *Nuclear Physics B -Proceedings Supplements* (229 times cited), *Nuclear Physics B* (160 times cited), and *Physical Review Letters* (140 times cited). The citing pattern of these five journals is depicted in Figure 10.

Table 4: Journals citing the 'hep-ex' e-print archives of LANL (1994-2002) in *Science Citation Index* (1991-2002)

Citing journal	Impact Factor	Number of times cited
PHYSICS LETTERS B	4.377	550
PHYSICAL REVIEW D	4.363	527
NUCLEAR PHYSICS B-PROCEEDINGS SUPPLEMENTS	0.947	229
NUCLEAR PHYSICS B	6.226	160
PHYSICAL REVIEW LETTERS	6.668	140
EUROPEAN PHYSICAL JOURNAL C	5.194	139
INTERNATIONAL JOURNAL OF MODERN PHYSICS A	1.541	88
JOURNAL OF PHYSICS G	1.182	87
ACTA PHYSICA POLONICA B	0.574	85
NUCLEAR PHYSICS A	2.074	83
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A	1.026	81
PHYSICS OF ATOMIC NUCLEI	0.463	52
MODERN PHYSICS LETTERS A	1.119	39
PHYSICAL REVIEW C	2.695	33
PROGRESS IN PARTICLE AND NUCLEAR PHYSICS	2.084	28
PRAMANA-JOURNAL OF PHYSICS	0.283	27
JOURNAL OF HIGH ENERGY PHYSICS	8.664	25

Citing journal	Impact Factor	Number of times cited
PHYSICS REPORTS-REVIEW SECTION OF PHYSICS LETTERS	8.341	15
PROGRESS OF THEORETICAL PHYSICS	1.681	14
CZECHOSLOVAK JOURNAL OF PHYSICS	0.345	13
EUROPEAN PHYSICAL JOURNAL A	1.725	12
PHYSICA SCRIPTA	0.772	12
ANNUAL REVIEW OF NUCLEAR AND PARTICLE SCIENCE	6.690	10
JETP LETTERS	1.377	10
ASTROPARTICLE PHYSICS	4.110	6
REVIEWS OF MODERN PHYSICS	12.762	6
RIVISTA DEL NUOVO CIMENTO	1.333	6
COMMUNICATIONS IN THEORETICAL PHYSICS	0.397	5
COMPUTER PHYSICS COMMUNICATIONS	1.082	5
JOURNAL OF EXPERIMENTAL AND THEORETICAL PHYSICS	1.156	5
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA A	0.697	5
REPORTS ON PROGRESS IN PHYSICS	8.879	5
NATURE	27.955	4
REVISTA MEXICANA DE FISICA	0.154	4
ANNALS OF PHYSICS	1.968	3
ASTROPHYSICAL JOURNAL	5.921	3
CONTEMPORARY PHYSICS	2.300	3
FORTSCHRITTE DER PHYSIK-PROGRESS OF PHYSICS	1.043	3
FOUNDATIONS OF PHYSICS	0.425	3
SPACE SCIENCE REVIEWS	1.601	3
ADVANCES IN NUCLEAR PHYSICS	6.667	2
ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES	5.214	2
EUROPHYSICS LETTERS	2.304	2
FUSION SCIENCE AND TECHNOLOGY	NA	2
HYPERFINE INTERACTIONS	0.634	2
MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY	4.681	2
PHYSICAL REVIEW A	2.810	2
PHYSICS LETTERS A	1.220	2
RADIATION MEASUREMENTS	1.003	2
SPRINGER TRACTS IN MODERN PHYSICS	0.446	2
THEORETICAL AND MATHEMATICAL PHYSICS	0.600	2
USPEKHI FIZICHESKIKH NAUK	NA	2
ANNALEN DER PHYSIK	1.590	1
APPLIED SURFACE SCIENCE	1.068	1
ASTROPHYSICS AND SPACE SCIENCE	0.274	1
ATOMIC DATA AND NUCLEAR DATA TABLES	3.194	1
CLASSICAL AND QUANTUM GRAVITY	2.041	1
COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE II	0.366	1
COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE IV	0.244	1
DOKLADY PHYSICS	NA	1
EUROPEAN PHYSICAL JOURNAL D	1.583	1
GENERAL RELATIVITY AND GRAVITATION	0.773	1
HELVETICA PHYSICA ACTA	0.520	1
IEEE TRANSACTIONS ON NUCLEAR SCIENCE	0.771	1
INSTRUMENTS AND EXPERIMENTAL TECHNIQUES	0.265	1

Citing journal	Impact Factor	Number of times cited
INTERNATIONAL JOURNAL OF MODERN PHYSICS B	0.523	1
INTERNATIONAL JOURNAL OF MODERN PHYSICS C	0.728	1
INTERNATIONAL JOURNAL OF THEORETICAL PHYSICS	0.520	1
JOURNAL OF LOW TEMPERATURE PHYSICS	0.954	1
JOURNAL OF MATHEMATICAL PHYSICS	1.151	1
JOURNAL OF PHYSICS A	1.542	1
JOURNAL OF THE KOREAN PHYSICAL SOCIETY	0.505	1
JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN	1.628	1
LETTERS IN MATHEMATICAL PHYSICS	0.819	1
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION B	1.041	1
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA B	0.331	1
PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY OF LONDON SERIES A	1.471	1
PHYSICAL REVIEW E	2.235	1
PHYSICS TODAY	4.790	1
PHYSICS-USPEKHI	NA	1
PROGRESS OF THEORETICAL PHYSICS SUPPLEMENT	0.635	1
ZEITSCHRIFT FUR PHYSIK A	NA	1

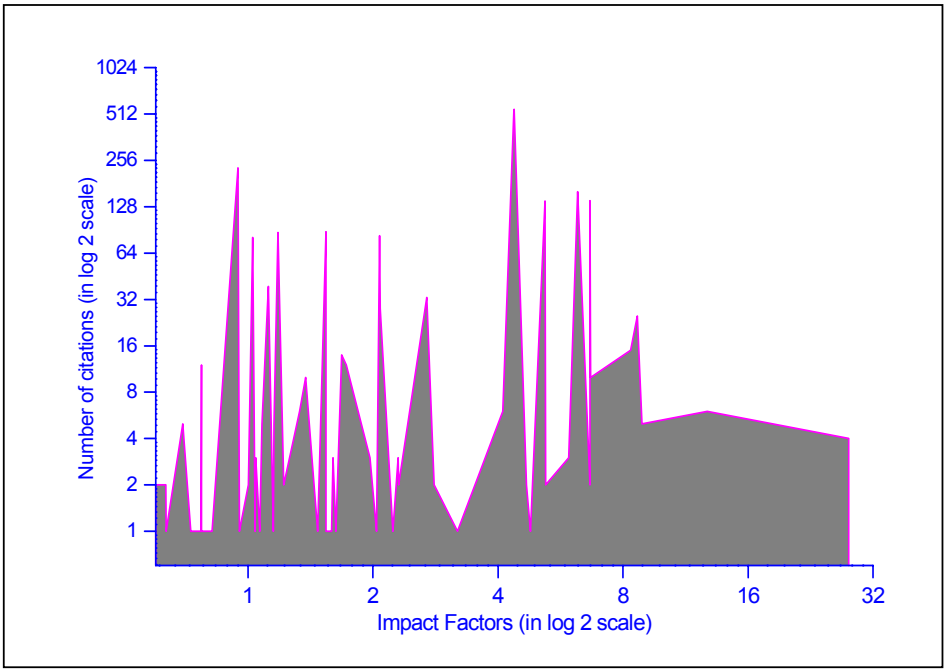

Figure 9: Relationship between the number of times cited and the corresponding Impact Factors of journals citing the 'hep-ex' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991 – 2002)

5.1.5 Highly Citing Authors and Countries

There are 4456 individual authors cited the 'hep-ex' e-print archives as per *Science Citation Index* during 1991-2002. Among the top citing authors, Ellis, J. comes first

with 30 times cited followed by Banerjee, S. (28 times), Barger, V. (27 times), Abe, K. (26 times), Valle, J.W.F. (23 times), Whisnant, K. (23 times), and Xing, Z.Z. (22 times). Table 5 documents the authors citing the 'hep-ex' e-print archives with the corresponding number of times cited. The number of authors citing the 'hep-ex' e-print archives is increasing year-by-year. The average percentage growth in number of authors citing e-print archives is 114 %. The year-wise number of authors citing the 'hep-ex' e-print archives as per *Science Citation Index* (1991-2002) is presented in Figure 11. Lotka's Law for the publication productivity has been applied to the information use by researchers in the form of citing the 'hep-ex' e-print archives. The graphical representation of the same is depicted in Figure 12.

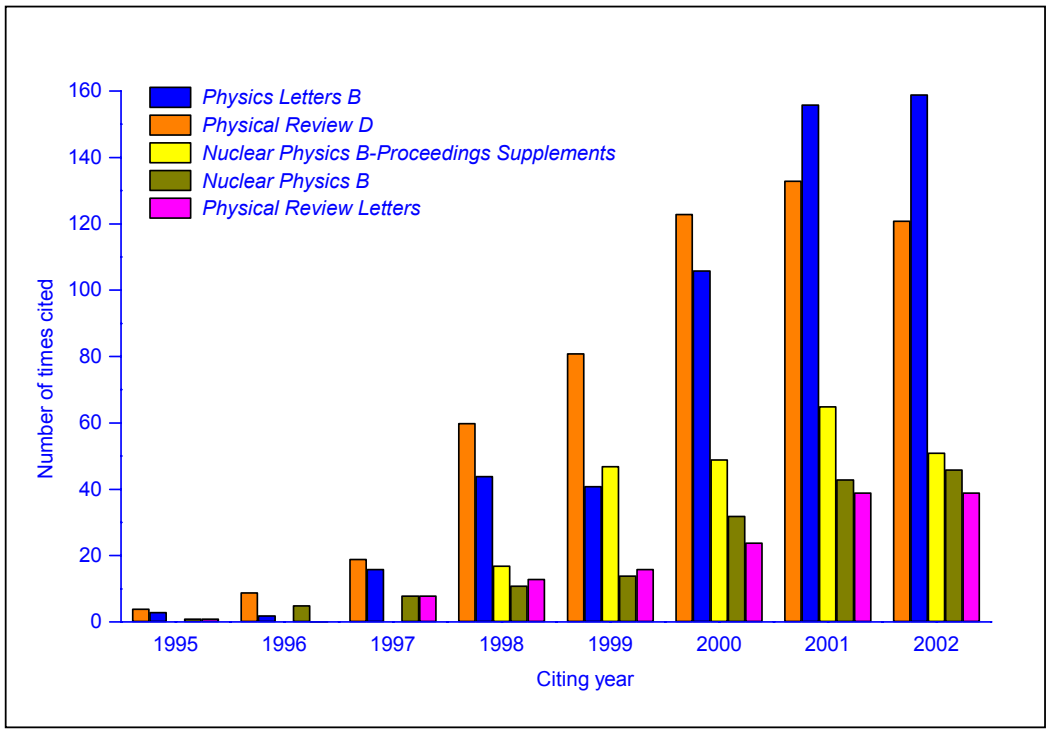

Figure 10: Citing pattern of the five journals, which are highly citing the 'hep-ex' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

Table 6 lists the countries in the affiliation of authors citing the 'hep-ex' e-print archives. The analysis reveals that, among the affiliation of scientists citing the 'hep-ex' e-print archives, 30.49 % are from USA followed by Italy (12.78 %), Germany (7.73 %), Japan (7.03 %), and Russia (4.35 %).

Table 5: Authors citing the 'hep-ex' archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

Citing author	No. of times cited	Citing author	No. of times cited	Citing author	No. of times cited
Ellis-J	30	Nunokawa-H	12	Akhmedov-EK	9
Banerjee-S	28	Petcov-ST	12	Allison-J	9
Barger-V	27	Rosner-JL	12	Aloisio-A	9
Abe-K	26	Volkas-RR	12	Altarelli-G	9
Valle-JWF	23	Abbiendi-G	11	Anderson-KJ	9
Whisnant-K	23	Abe-T	11	Arcelli-S	9
Xing-ZZ	22	Adachi-I	11	Asai-S	9
Giunti-C	18	Alexander-G	11	Axen-D	9
Mohapatra-RN	18	Anselmo-F	11	Ban-Y	9
Abbott-B	17	Aushev-T	11	Barberio-E	9
Datta-A	17	Bakich-AM	11	Barlow-RJ	9
Smirnov-AY	17	Baringer-P	11	Bella-G	9
Ma-E	16	Bethke-S	11	Bell-KW	9
Strumia-A	16	Bondar-A	11	Beloborodov-KI	9
Bilenky-SM	14	Bozek-A	11	Buras-AJ	9
Feng-JL	14	Brodsky-SJ	11	Chen-CH	9
Gonzalezgarcia-MC	14	Chao-Y	11	Debarbaro-P	9
Ivanchenko-VN	14	Cheon-BG	11	Fritzsch-H	9
Schmidt-I	14	Close-FE	11	Gobel-C	9
Achasov-MN	13	Dubrovin-MS	11	Haba-N	9
Asano-Y	13	Foot-R	11	Khalil-S	9
Browder-TE	13	He-XG	11	Koop-IA	9
Bukin-DA	13	Kim-CS	11	Lebedev-O	9
Burdin-SV	13	King-SF	11	Li-HN	9
Dimova-TV	13	Lisi-E	11	Lola-S	9
Druzhinin-VP	13	Ma-BQ	11	Marrone-A	9
Golubev-VB	13	Ohlsson-T	11	Sato-J	9
Korol-AA	13	Olive-KA	11	Stirling-WJ	9
Yang-JM	13	Rizzo-TG	11	Aguilarbenitez-M	8
Abolins-M	12	Schafer-A	11	Akesson-PF	8
Abramov-V	12	Thomas-AW	11	Amato-S	8
Acharya-BS	12	Yang-JJ	11	Anjos-JC	8
Adams-DL	12	Ahn-BS	10	Baer-H	8
Adams-M	12	Akatsu-M	10	Bailey-I	8
Aihara-H	12	Aso-T	10	Balazs-C	8
Alves-GA	12	Aulchenko-V	10	Barenboim-G	8
Amos-N	12	Azuelos-G	10	Bartlett-JF	8
Anderson-EW	12	Banas-E	10	Bediaga-I	8
Baarmand-MM	12	Behera-PK	10	Behnke-T	8
Babintsev-VV	12	Casey-BCK	10	Bellerive-A	8
Babukhadia-L	12	Chang-P	10	Biebel-O	8
Baden-A	12	Chistov-R	10	Bueno-A	8
Baldin-B	12	Deroeck-A	10	Bukin-AD	8
Barberis-E	12	Fogli-GL	10	Cheng-HY	8
Belyaev-A	12	Gaponenko-IA	10	Chen-GP	8
Berdyugin-AV	12	Hou-WS	10	Choi-Y	8
Bozhenok-AV	12	Matchev-KT	10	Diaz-MA	8
Klapdorkleingrothaus-HV	12	Minakata-H	10	Dutta-B	8
Koshuba-SV	12	Pakhtusova-EV	10	Eboli-OJP	8
Marfatia-D	12	Rubbia-A	10	Faessler-A	8

Citing author	No. of times cited
Faustov-RN	8
Geng-CQ	8
Grimus-W	8
Gronau-M	8
Han-T	8
Kajita-T	8
Kang-SK	8
Kirk-A	8
Lindner-M	8
Martin-AD	8
Mukhopadhyaya-B	8
Pakvasa-S	8
Romanino-A	8
Roy-DP	8
Sarkar-U	8
Shafi-Q	8
Soffer-J	8
Soni-A	8
Zhang-X	8
Achasov-NN	7
Ackerstaff-K	7
Adriani-O	7
Ahn-S	7
Akeroyd-AG	7
Alcaraz-J	7
Alemanni-G	7
Ali-A	7
Allaby-J	7
Alviggi-MG	7
Ambrosi-G	7
Anderhub-H	7
Andreev-VP	7
Andrieu-B	7

Citing author	No. of times cited
Angelescu-T	7
Anisovich-VV	7
Arefiev-A	7
Arnoud-Y	7
Artuso-M	7
Aulchenko-VM	7
Avakian-H	7
Azemoon-T	7
Aziz-T	7
Babaev-A	7
Bagnaia-P	7
Baksay-L	7
Bantly-J	7
Barbieri-R	7
Barrelet-E	7
Bartel-W	7
Beri-SB	7
Bianchi-N	7
Bonvicini-G	7
Bracko-M	7
Butler-JN	7
Choudhury-D	7
Dedes-A	7
Donini-A	7
Drees-M	7
Eigen-G	7
Feruglio-F	7
Gavela-MB	7
Gluza-J	7
Huang-T	7
Kitabayashi-T	7
Kobayashi-T	7
Ko-P	7

Citing author	No. of times cited
Lee-J	7
Link-JM	7
Lipari-P	7
Mcdermott-M	7
Nardulli-G	7
Nath-P	7
Ng-JN	7
Nir-Y	7
Novaes-SF	7
Pich-A	7
Porod-W	7
Repond-J	7
Rodejohann-W	7
Ryskin-MG	7
Silvestrini-L	7
Strikman-M	7
Teryaev-OV	7
Thorne-RS	7
Vissani-F	7
Xiao-ZJ	7
Yasuda-O	7
Yasue-M	7
Yuan-CP	7
Authors citing six times	82
Authors citing five times	227
Authors citing four times	196
Authors citing three times	430
Authors citing two times	765
Authors citing only once	2512

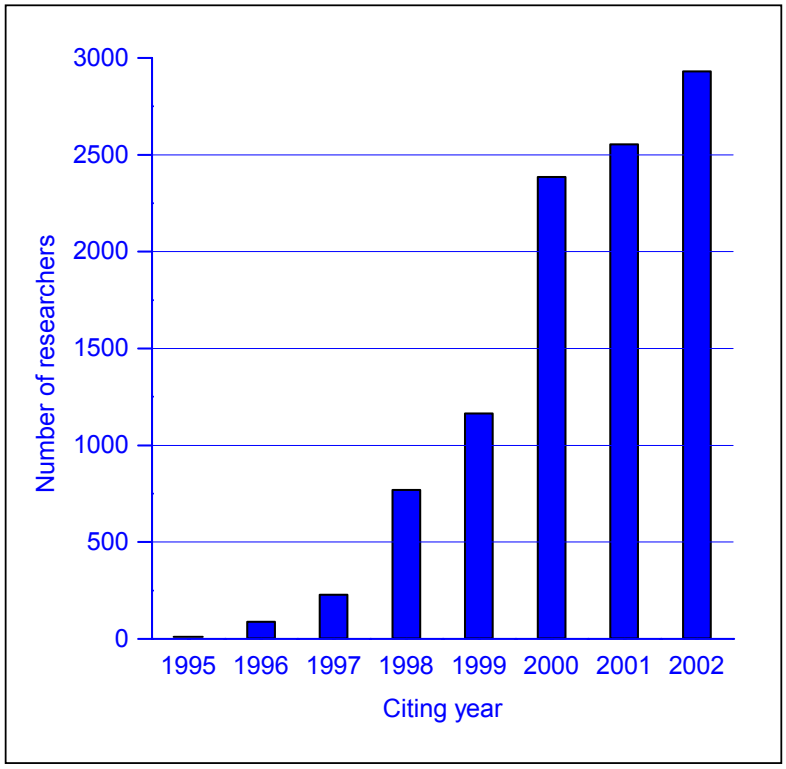

Figure 11: Number of researchers citing the 'hep-ex' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

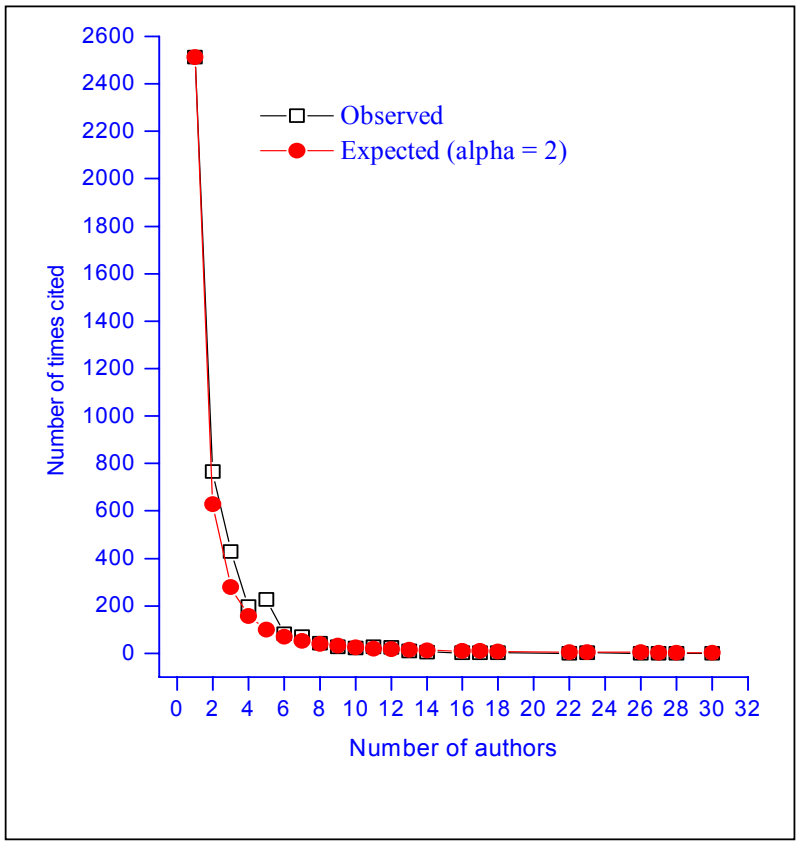

Figure 12: Lotka's Law applied to information use by authors citing the 'hep-ex' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

Table 6: Countries occurring in the affiliation of the citing authors of the 'hep-ex' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

Citing Country	Number of occurence	%
USA	3214	30.49
ITALY	1347	12.78
GERMANY	815	7.73
JAPAN	741	7.03
RUSSIA	459	4.35
ENGLAND	427	4.05
SWITZERLAND	378	3.59
FRANCE	368	3.49
PEOPLES-R-CHINA	307	2.91
CANADA	237	2.25
SOUTH-KOREA	231	2.19
SPAIN	217	2.06
INDIA	211	2.00
POLAND	176	1.67
TAIWAN	149	1.41
BRAZIL	124	1.18
ISRAEL	111	1.05
NETHERLANDS	97	0.92
AUSTRALIA	78	0.74
MEXICO	62	0.59
BELGIUM	52	0.49
HUNGARY	51	0.48
SWEDEN	51	0.48
FINLAND	50	0.47
SLOVENIA	49	0.46
GREECE	48	0.46
PORTUGAL	45	0.43
CZECH-REPUBLIC	39	0.37
AUSTRIA	36	0.34
SCOTLAND	33	0.31
NORWAY	28	0.27
TURKEY	28	0.27
ARGENTINA	27	0.26
CHILE	23	0.22
BULGARIA	21	0.20
SLOVAKIA	21	0.20
ROMANIA	18	0.17
COLOMBIA	16	0.15
DENMARK	16	0.15
UKRAINE	15	0.14
REP-OF-GEORGIA	14	0.13
CROATIA	13	0.12
ARMENIA	12	0.11
ECUADOR	10	0.09
CYPRUS	9	0.09
EGYPT	9	0.09
MOROCCO	7	0.07
BYELARUS	6	0.06
IRAN	5	0.05
NEW-ZEALAND	5	0.05
PERU	5	0.05
ESTONIA	3	0.03
JORDAN	3	0.03
KAZAKHSTAN	3	0.03
SAUDI-ARABIA	3	0.03
URUGUAY	3	0.03
VENEZUELA	3	0.03
WALES	3	0.03
PAKISTAN	2	0.02
SOUTH-AFRICA	2	0.02
ALGERIA	1	0.01
AZERBAIJAN	1	0.01
INDONESIA	1	0.01
IRELAND	1	0.01
Total	**10540**	**100.00**

5.2 High Energy Physics - Lattice (hep-lat) E-Print Archives

The 'hep-lat' e-print archives of LANL are for preprints in lattice field theory papers started from December 1, 1991 (http://www.arxiv.org/list/hep-lat/info). The archive is for topics of research covered at the Lattice conferences: Lattice QCD (numerical and analytical), particle spectrum, finite temperature QCD, Weak interaction physics, QED, algorithms, spin systems, random surfaces/quantum gravity, Special purpose computers, comparison with experiments and other analytical developments. There were a total of 5564 e-prints were added to this category till 2002. A steady growth can be observed in the number of submissions in each year in this category. The following sections discuss the growth of citations to the 'hep-lat' e-print archives, frequency of citations, sources citing, and citing authors and countries in the affiliation of the citing authors as per *Science Citation Index* (1991-2002).

5.2.1 Growth of Citations

Among the total of 5564 e-print archives submitted to the the 'hep-lat' category, 2127 e-prints (38.23 %) have cited at least once as per *Science Citation Index* (1991-2002). On an average of 35.94 % of e-print archives in the category are cited at least once per year. The number of e-print archives cited once versus the number of submissions from 1992 to 2002 is presented in Figure 13. There is a gradual and parallel growth in number of citations with the growth in number of submissions to this category.

5.2.2 Frequency of Citations

The citations to each e-print archives have been assumed as the quantitative measurement of quality of e-print archives. When the citing frequency is considered as the income of the e-print archives, the Lorenz Curve for the same is depicted in Figure 14. Gini's Coefficient was computed for the category and it was found 0.61.

5.2.3 Highly Cited E-Print Archives

The average number of citations received to the individual 'hep-lat' e-print archives of LANL (1991-2002) was 2.73 as per *Science Citation Index* (1991–2002). Table 7 gives a list of ten highly cited the 'hep-lat' e-print archives with the name of author(s), title, comments, published sources etc. The citations received to these e-print archives as per *Science Citation Index* (1991 – 2002) if they are published in a formal source are also documented. Figure 15 depicts the year-wise citing pattern of top ten highly cited e-print archives. On an average 70.32 % of the citations are received with in two

years after the submission. The e-print archive 'hep-lat/9812003', which is highly cited, has almost equal distribution of citations in each citing years. Even though the immediacy impact is very less for the e-print archive 'hep-lat/0007038', the citations for the next two years are very high. Similarly for 'hep-lat/0107021' has less immediacy impact but in the next year the citations are high.

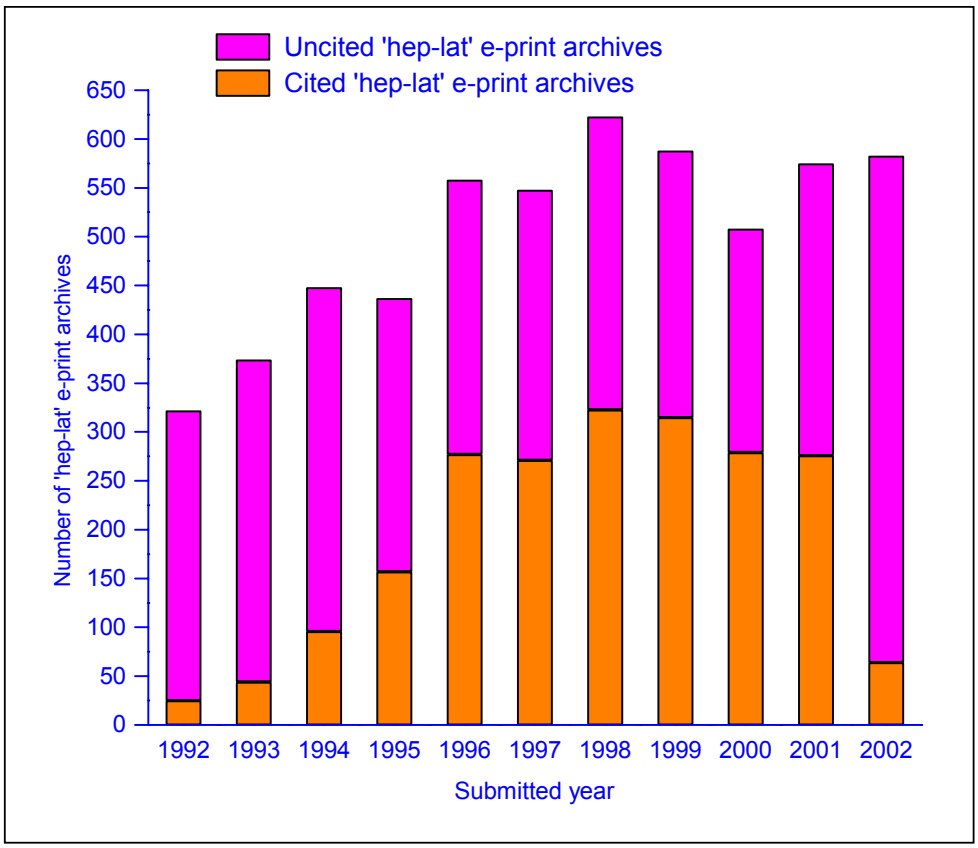

Figure 13: Number of the 'hep-lat' e-print archives of LANL (1991-2002) cited at least once and uncited as per *Science Citation Index* (1991 – 2002)

Table 7: Highly cited ten 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

E-Print archive	Title, Author(s), Comments, Published source etc.	Citations received		
		Before publishing	Before publishing	Total
hep-lat/9812003	Axial anomaly and topological charge in lattice gauge theory with Overlap Dirac operator Author: David H. Adams Comments: Latex, 33 pages. v6: shortened and (hopefully) more succinct version, to appear in Ann.Phys Subj-class: High Energy Physics - Lattice; Mathematical Physics Journal-ref: Annals Phys. 296 (2002) 131-151	35	2	37
hep-lat/0007038	Quenched Lattice QCD with Domain Wall Fermions and the Chiral Limit Authors: T. Blum, P. Chen, N. Christ, C. Cristian, C. Dawson, G. Fleming, A. Kaehler, X. Liao, G. Liu, C. Malureanu, R. Mawhinney, S. Ohta, G. Siegert, A. Soni, C. Sui, P. Vranas, M. Wingate, L. Wu, Y. Zhestkov Comments: 91 pages, 34 figures Report-no: CU-TP-980, BNL-HET-00/20, RBRC-113 Journal-ref: Phys.Rev. D69 (2004) 074502	32	0	32
hep-lat/9802029	Advanced Lattice QCD Authors: Martin Lüscher Comments: Lectures given at the Les Houches Summer School ``Probing the Standard Model of Particle Interactions", July 28 -- September 5, 1997, latex source, 55 pages, 18 figures, style file included Report-no: DESY 98-017	19	13	32
hep-lat/9811006	Progress in Lattice Gauge Theory Authors: Stephen R. Sharpe Comments: 20 pages, 10 figures, uses ltwol2e.sty. Plenary talk at ICHEP98 (references updated and acknowledgement revised)	24	7	31
hep-lat/9710057	Heavy Quark Physics From Lattice QCD Authors: J. M. Flynn, C. T. Sachrajda (University of Southampton) Comments: 52 pages LaTeX with 10 eps files. Requires: hfsprocl.sty (included) plus axodraw.sty, rotating.sty and array.sty. To appear in Heavy Flavours (2nd edition) edited by A J Buras and M Lindner (World Scientific, Singapore). Revised version corrects typo in axis labelling of Fig 10 Report-no: SHEP 97/20 Journal-ref: Adv.Ser.Direct.High Energy Phys. 15 (1998) 402-452	21	6	27
hep-lat/9902022	Low energy effective action of domain-wall fermion and the Ginsparg-Wilson relation Authors: Y. Kikukawa, T. Noguchi (Kyoto Univ.) Comments: 35 pages, LaTeX2e, references added and updated, minor corrections Report-no: KUNS-1560	24	0	24
hep-lat/9902012	Two Colours QCD at Nonzero Chemical Potential Authors: Susan Morrison, Simon Hands (University of Wales Swansea) Comments: 5 pages, contribution to 'Strong and Electroweak Matter 98', Coepnhagen, Dec. 1998 Report-no: SWAT/217	19	2	21
hep-lat/0107021	Effects of non-perturbatively improved dynamical fermions in QCD at fixed lattice spacing Authors: UKQCD Collaboration: C.R. Allton, S.P. Booth, K.C. Bowler, J. Garden, A. Hart, D. Hepburn, A.C. Irving, B. Joo, R.D. Kenway, C.M. Maynard, C. McNeile, C. Michael, S.M. Pickles, J.C. Sexton, K.J. Sharkey, Z. Sroczynski, M. Talevi, M. Teper, H. Wittig Comments: 53 pages, LaTeX/RevTeX, 16 eps figures; corrected clover action expression and various typos, no results changed Report-no: Cambridge DAMTP-2001-15, Edinburgh 2001/09, Liverpool LTH509, Oxford OUTP-01-37P, Swansea SWAT/307 Journal-ref: Phys.Rev. D65 (2002) 054502	18	2	20
hep-lat/9603017	Field strength correlations in the QCD vacuum at short distance Authors: Adriano Di Giacomo, Enrico Meggiolaro, Haralambos Panagopoulos Comments: 9 pages, LaTeX file, + 3 PS figures, uuencoded-tar-compressed Report-no: IFUP--TH 12/96, UCY--PHY--96/5	18	0	18
hep-lat/9802017	Topological Properties of the QCD Vacuum at T=0 and T ~ T_c Authors: Philippe de Forcrand, Margarita Garcia Perez, James E. Hetrick, Ion-Olimpiu Stamatescu Comments: Latex, 7 pages, 4 figures (one colour). Contribution to the 31st International Symposium Ahrenshoop on the Theory of Elementary Particles, Buckow, September 2-6, 1997	18	0	18

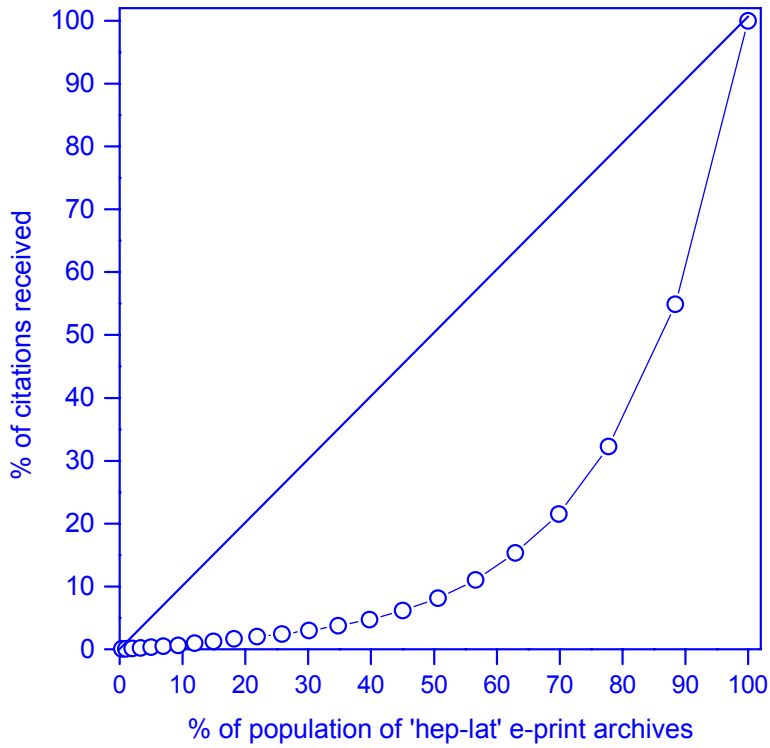

Figure 14: Lorenz curve showing the distribution of citations received to the 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

5.2.4 Highly Citing Sources

The sources citing the 'hep-lat' e-print archives are all journal articles. The total number of journals citing the 'hep-lat' e-print archives as per *Science Citation Index* (1991-2002) was 68. Table 8 lists the journals with the number of times cited, and corresponding Impact Factors. In case an article is citing more than one e-print archives, then the number of times cited by the journal is counted as one. The average Impact Factor (IF) of these journals is 2.65 (Impact Factors of two journals could not be identified). The number of citations versus Corresponding Impact Factors of these journals is depicted in Figure 16. Lot of variations are observed.

The five journals citing frequently the 'hep-lat' e-print archives as per *Science Citation Index* (1991-2002) are *Nuclear Physics B -Proceedings Supplements* (652 times) followed by *Nuclear Physics B* (509 times), *Physical Review D* (442 times), *Physics Letters B* (391 times), and *Nuclear Physics A* (114 times). The citing pattern of these five journals is depicted in Figure 17.

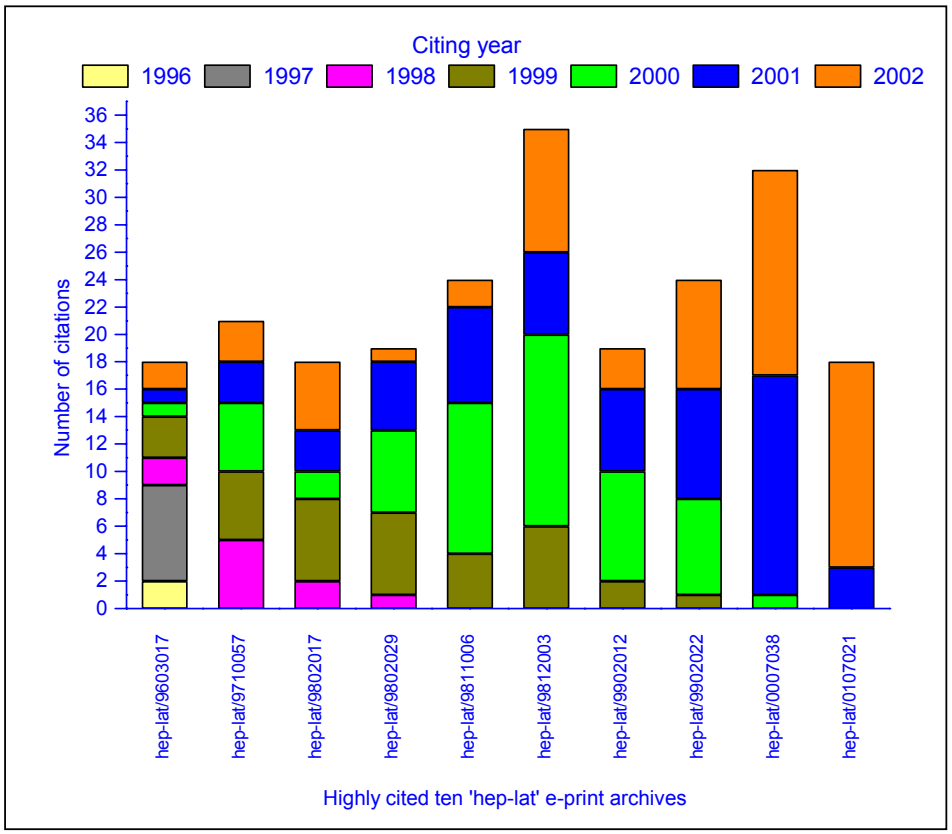

Figure 15: Citing pattern of highly cited ten 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Table 8: Journals citing the 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Citing journal	**Impact Factor**	**Number of times cited**
NUCLEAR PHYSICS B-PROCEEDINGS SUPPLEMENTS	0.947	652
NUCLEAR PHYSICS B	6.226	509
PHYSICAL REVIEW D	4.363	442
PHYSICS LETTERS B	4.377	391
NUCLEAR PHYSICS A	2.074	114
PHYSICAL REVIEW LETTERS	6.668	68
INTERNATIONAL JOURNAL OF MODERN PHYSICS A	1.541	42
EUROPEAN PHYSICAL JOURNAL C	5.194	38
ACTA PHYSICA POLONICA B	0.574	30
PHYSICAL REVIEW C	2.695	28
JOURNAL OF PHYSICS A	1.542	27
MODERN PHYSICS LETTERS A	1.119	27
JOURNAL OF PHYSICS G	1.182	21
COMPUTER PHYSICS COMMUNICATIONS	1.082	20
PROGRESS OF THEORETICAL PHYSICS	1.681	20
PROGRESS OF THEORETICAL PHYSICS SUPPLEMENT	0.635	19
PHYSICS OF ATOMIC NUCLEI	0.463	18
CHINESE JOURNAL OF PHYSICS	0.365	17
PHYSICS REPORTS-REVIEW SECTION OF PHYSICS LETTERS	8.341	17
PHYSICAL REVIEW E	2.235	13

Citing journal	Impact Factor	Number of times cited
JOURNAL OF HIGH ENERGY PHYSICS	8.664	12
JOURNAL OF MATHEMATICAL PHYSICS	1.151	11
ANNALS OF PHYSICS	1.968	10
JETP LETTERS	1.377	9
INTERNATIONAL JOURNAL OF MODERN PHYSICS B	0.523	8
INTERNATIONAL JOURNAL OF MODERN PHYSICS C	0.728	8
CHINESE PHYSICS LETTERS	0.813	6
COMMUNICATIONS IN THEORETICAL PHYSICS	0.397	6
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A	1.026	6
PHYSICA SCRIPTA	0.772	5
REVIEWS OF MODERN PHYSICS	12.762	5
ANNUAL REVIEW OF NUCLEAR AND PARTICLE SCIENCE	6.690	4
EUROPEAN PHYSICAL JOURNAL A	1.725	4
FORTSCHRITTE DER PHYSIK-PROGRESS OF PHYSICS	1.043	4
JOURNAL OF STATISTICAL PHYSICS	1.241	4
PHYSICA A	1.295	4
PRAMANA-JOURNAL OF PHYSICS	0.283	4
USPEKHI FIZICHESKIKH NAUK	NA	4
CLASSICAL AND QUANTUM GRAVITY	2.041	3
EUROPEAN PHYSICAL JOURNAL B	1.811	3
EUROPHYSICS LETTERS	2.304	3
PHYSICAL REVIEW B	3.070	3
THEORETICAL AND MATHEMATICAL PHYSICS	0.600	3
ZEITSCHRIFT FUR PHYSIK C-PARTICLES AND FIELDS	NA	3
AUSTRALIAN JOURNAL OF PHYSICS	0.657	2
CZECHOSLOVAK JOURNAL OF PHYSICS	0.345	2
JOURNAL OF CHEMICAL PHYSICS	3.147	2
JOURNAL OF COMPUTATIONAL PHYSICS	1.716	2
JOURNAL OF EXPERIMENTAL AND THEORETICAL PHYSICS	1.156	2
JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN	1.628	2
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA A	0.697	2
PROGRESS IN PARTICLE AND NUCLEAR PHYSICS	2.084	2
REVISTA MEXICANA DE FISICA	0.154	2
RIVISTA DEL NUOVO CIMENTO	1.333	2
ADVANCES IN NUCLEAR PHYSICS	6.667	1
FEW-BODY SYSTEMS	1.857	1
FOUNDATIONS OF PHYSICS	0.425	1
FOUNDATIONS OF PHYSICS LETTERS	0.380	1
HELVETICA PHYSICA ACTA	0.520	1
JOURNAL OF THE KOREAN PHYSICAL SOCIETY	0.505	1
LETTERS IN MATHEMATICAL PHYSICS	0.819	1
MODERN PHYSICS LETTERS B	0.438	1
NATURE	27.955	1
PHYSICA E	1.009	1
PHYSICS LETTERS A	1.220	1
PHYSICS TODAY	4.790	1
REPORTS ON PROGRESS IN PHYSICS	8.879	1
SPECTROCHIMICA ACTA PART A	0.838	1

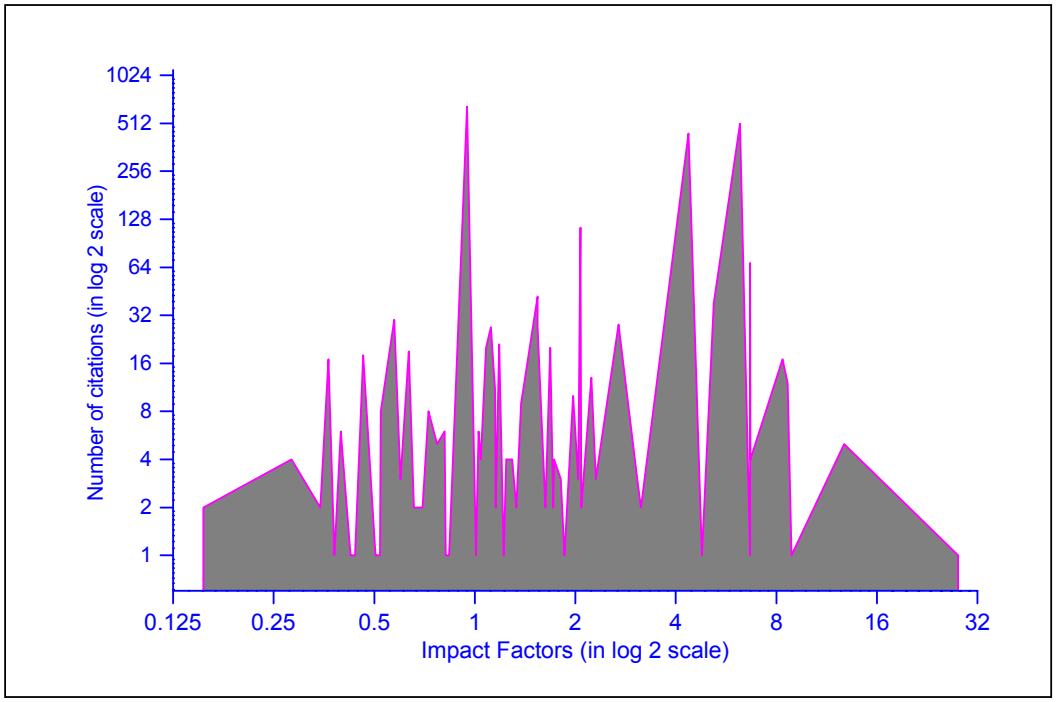

Figure 16: Relationship between the number of times cited and the corresponding Impact Factors of journals citing the 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991 – 2002)

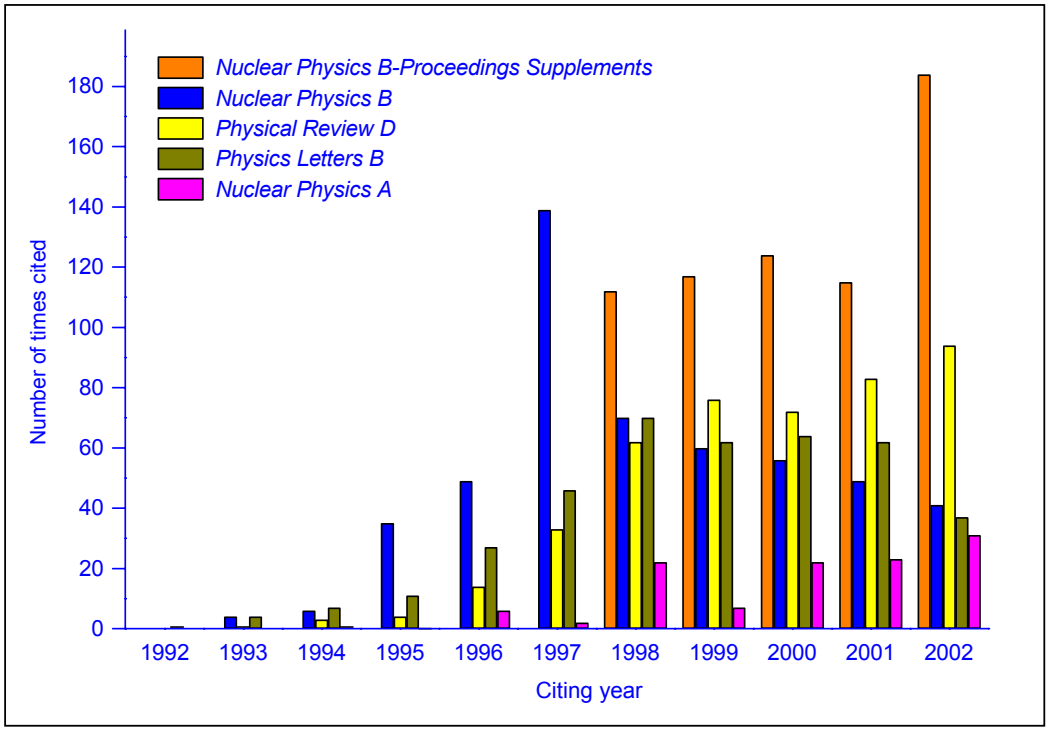

Figure 17: Citing pattern of the five journals citing highly the 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

5.2.5 Highly Citing Authors and Countries

There are 2327 individual authors cited the 'hep-lat' e-print archives as per *Science Citation Index* during 1991-2002. Among the top citing authors, Aoki, S. comes first with 67 times cited followed by Heller, U.M. (63 times), Hashimoto, S. (59 times), Ukawa, A. (58 times), and Kanaya, K. (56 times). Table 9 documents the authors citing the 'hep-lat' e-print archives with the corresponding number of times cited. The number of authors citing the 'hep-lat' e-print archives is increasing year-by-year. The average percentage growth in number of authors citing e-print archives is 186.91 %. The year-wise number of authors citing the 'hep-lat' e-print archives as per *Science Citation Index* (1991-2002) is presented in Figure 18. Lotka's Law for the publication productivity has been applied to the information use by researchers in the form of citing the 'hep-lat' e-print archives. The graphical representation of the same is depicted in Figure 19.

Table 10 presents the countries in the affiliation of authors citing the 'hep-lat' e-print archives. The analysis shows that, among the affiliation of scientists citing the 'hep-lat' e-print archives, 25.14 % are from USA followed by Germany (15.31 %), Italy (12.38 %), Japan (11.47 %), and Switzerland (4.31 %).

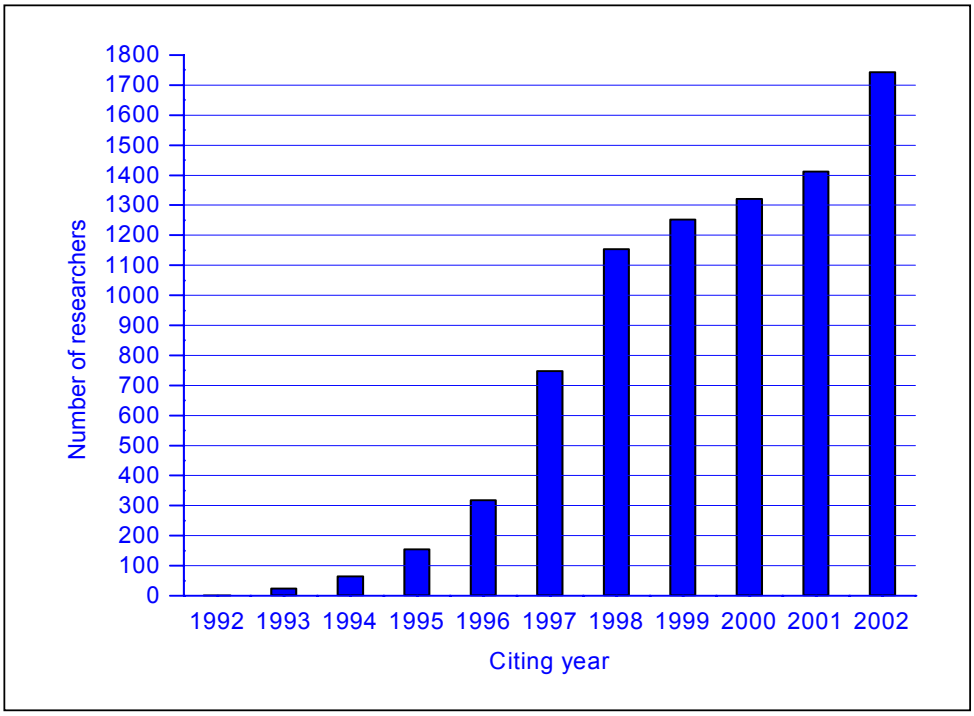

Figure 18: Number of researchers citing the 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Table 9: Authors citing the 'hep-lat' archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Citing author	No. of times cited	Citing author	No. of times cited	Citing author	No. of times cited
Aoki-S	67	Gattringer-C	20	Shamir-Y	15
Heller-UM	63	Hasenfratz-A	20	Sharpe-S	15
Hashimoto-S	59	Kovacs-TG	20	Zhang-JB	15
Ukawa-A	58	Polikarpov-MI	20	Chandrasekharan-S	14
Kanaya-K	56	Schafer-A	20	Dong-SJ	14
Kuramashi-Y	54	Shanahan-HP	20	Horvath-I	14
Yoshie-T	53	Thomas-AW	20	Luscher-M	14
Iwasaki-Y	49	Williams-AG	20	Manke-T	14
Okawa-M	49	Zakharov-VI	20	Sinclair-DK	14
Ishizuka-N	48	Gupta-R	19	Stamatescu-IO	14
Fukugita-M	47	Horsley-R	19	Takaishi-T	14
Deforcrand-P	38	Michael-C	19	Talevi-M	14
Martinelli-G	33	Montvay-I	19	Teper-M	14
Schilling-K	33	Simonov-YA	19	Weisz-P	14
Ejiri-S	32	Wettig-T	19	Faber-M	13
Kaneko-T	32	Bhattacharya-T	18	Fodor-Z	13
Burkhalter-R	31	Bietenholz-W	18	Gubarev-FV	13
Toussaint-D	31	Chiu-TW	18	Hart-A	13
Edwards-RG	29	Markum-H	18	Luo-XQ	13
Ilgenfritz-EM	28	Miyamura-O	18	Negele-JW	13
Jansen-K	28	Niedermayer-F	18	Orginos-K	13
Karsch-F	28	Schierholz-G	18	Pelissetto-A	13
Leinweber-DB	27	Wingate-M	18	Philipsen-O	13
Sommer-R	27	Wittig-H	18	Shuryak-E	13
Bernard-C	26	Becirevic-D	17	Umeda-T	13
Degrand-T	26	Guagnelli-M	17	Veselov-AI	13
Giusti-L	26	Hasenbusch-M	17	Ambjorn-J	12
Gockeler-M	26	Izubuchi-T	17	Delia-M	12
Gottlieb-S	26	Laine-M	17	Greensite-J	12
Damgaard-PH	25	Nagai-K	17	Gusken-S	12
Kogut-JB	25	Rapuano-F	17	Hernandez-P	12
Lippert-T	25	Reinhardt-H	17	Langfeld-K	12
Mcneile-C	25	Schiller-A	17	Narison-S	12
Neuberger-H	25	Alles-B	16	Provero-P	12
Rummukainen-K	25	Boucaud-P	16	Sachrajda-CT	12
Laermann-E	24	Deldebbio-L	16	Savage-MJ	12
Rakow-PEL	24	Frezzotti-R	16	Suzuki-H	12
Taniguchi-Y	24	Heitger-J	16	Toublan-D	12
Blum-T	23	Lee-FX	16	Vladikas-A	12
Narayanan-R	23	Mullerpreussker-M	16	Wiese-UJ	12
Verbaarschot-JJM	23	Yamada-N	16	Wolff-U	12
Chernodub-MN	22	Capitani-S	15	Zahed-I	12
Gimenez-V	22	Digiacomo-A	15	Alexandrou-C	11
Lang-CB	22	Fujikawa-K	15	Aoki-Y	11
Matsufuru-H	22	Gavai-RV	15	Bialas-P	11
Nakamura-A	22	Hasenfratz-P	15	Close-FE	11
Detar-C	21	Ishikawa-KI	15	Cucchieri-A	11
Hip-I	21	Kikukawa-Y	15	Datta-S	11
Khan-AA	21	Liu-KF	15	Davies-CTH	11
Lubicz-V	21	Perez-MG	15	Farchioni-F	11
Onogi-T	21	Petronzio-R	15	Hetrick-J	11
Eicker-N	20	Pleiter-D	15	Hioki-S	11

Citing author	No. of times cited
Ji-XD	11
Kajantie-K	11
Kerler-W	11
Olejnik-S	11
Pepe-M	11
Suganuma-H	11
Trottier-HD	11
Allton-CR	10
Bonnet-FDR	10
Burda-Z	10
Csikor-F	10
Draper-T	10
Duncan-A	10
Eichten-E	10
Fernandez-LA	10
Fosco-CD	10
Hashimoto-T	10
Holland-K	10
Klassen-TR	10
Panagopoulos-H	10
Schafer-T	10
Sint-S	10
Soni-A	10
Thurner-S	10
Vanbaal-P	10
Vicari-E	10
Azcoiti-V	9
Bali-GS	9
Buras-AJ	9
Caselle-M	9
Cea-P	9
Degrand-TA	9
Donini-A	9
Gupta-S	9
Hands-S	9
Lellouch-L	9
Liu-C	9
Lombardo-MP	9
Martinmayor-V	9
Mendes-T	9
Nishimura-J	9
Petersson-B	9
Reisz-T	9
Silvestrini-L	9
Simma-H	9
Sugar-R	9
Sugar-RL	9
Testa-M	9
Thacker-H	9
Toki-H	9
Tominaga-S	9
Ueberholz-P	9
Viehoff-J	9
Vranas-P	9

Citing author	No. of times cited
Woloshyn-RM	9
Adams-DH	8
Alford-M	8
Antonov-D	8
Ballesteros-HG	8
Catterall-S	8
Chen-JW	8
Christ-N	8
Cosmai-L	8
Derafael-E	8
Dicarlo-G	8
Galante-A	8
Golterman-MFL	8
Hetrick-JE	8
Kaczmarek-O	8
Kroger-H	8
Kronfeld-AS	8
Lacock-P	8
Lagae-JF	8
Lepage-GP	8
Leroy-JP	8
Maynard-CM	8
Mitrjushkin-VK	8
Nagai-KI	8
Neff-H	8
Neuhaus-T	8
Okamoto-M	8
Pene-O	8
Roberts-CD	8
Rossi-GC	8
Seiler-E	8
Shigemitsu-J	8
Siegert-G	8
Splittorff-K	8
Stephanov-MA	8
Sudupe-AM	8
Suzuki-T	8
Thorleifsson-G	8
Tomboulis-ET	8
Tsutsui-N	8
Vairo-A	8
Wenger-U	8
Wetterich-C	8
Yamada-A	8
Authors citing seven times	63
Authors citing six times	44
Authors citing five times	83
Authors citing four times	98
Authors citing three times	233
Authors citing two times	372
Authors citing only once	1180

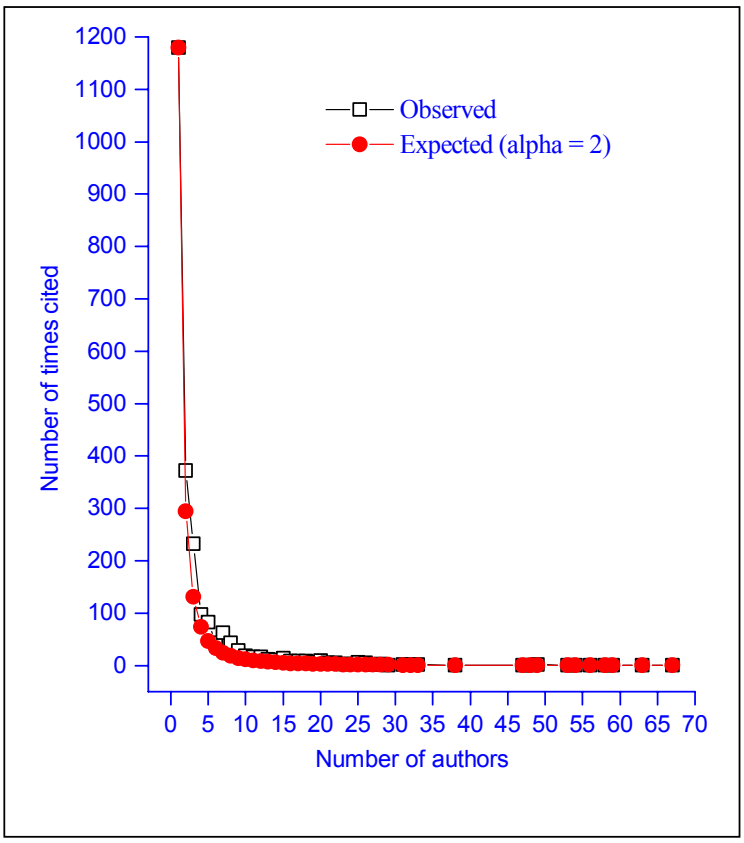

Figure 19: Lotka's Law applied to information use by authors citing the 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Table 10: Countries in the affiliation of the citing authors of the 'hep-lat' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Citing Country	Number of occurence	%
USA	1527	25.14
GERMANY	930	15.31
ITALY	752	12.38
JAPAN	697	11.47
SWITZERLAND	262	4.31
ENGLAND	199	3.28
FRANCE	195	3.21
RUSSIA	181	2.98
SPAIN	159	2.62
AUSTRALIA	125	2.06
DENMARK	99	1.63
PEOPLES-R-CHINA	97	1.60
SCOTLAND	93	1.53
CANADA	82	1.35
AUSTRIA	81	1.33
FINLAND	58	0.95
INDIA	54	0.89
POLAND	52	0.86
NETHERLANDS	47	0.77
HUNGARY	42	0.69
WALES	37	0.61
BRAZIL	32	0.53
ISRAEL	29	0.48
TAIWAN	28	0.46
GREECE	24	0.40
ARGENTINA	21	0.35
CYPRUS	20	0.33
UKRAINE	19	0.31
SOUTH-KOREA	18	0.30
IRELAND	16	0.26
SLOVAKIA	13	0.21
SWEDEN	11	0.18
PORTUGAL	10	0.16
NORWAY	9	0.15
BELGIUM	8	0.13
MEXICO	7	0.12
URUGUAY	5	0.08
CHILE	4	0.07
SOUTH-AFRICA	4	0.07
ARMENIA	3	0.05
EGYPT	3	0.05
SLOVENIA	3	0.05
TURKEY	3	0.05
HONG-KONG	2	0.03
MOROCCO	2	0.03
NEW-ZEALAND	2	0.03
SRI-LANKA	2	0.03
ALGERIA	1	0.02
AZERBAIJAN	1	0.02
COLOMBIA	1	0.02
KAZAKHSTAN	1	0.02
LEBANON	1	0.02
MONGOL-PEO-REP	1	0.02
ROMANIA	1	0.02
SINGAPORE	1	0.02
Total	**6075**	**100.00**

5.3 High Energy Physics - Phenomenology (hep-ph) E-Print Archives

The 'hep-ph' e-print archives of LANL are for particle phenomenology preprints started from March 7, 1992 (http://www.arxiv.org/list/hep-ph/info). There were a total of 35420 e-prints are submitted to this category till 2002. A steady growth can be observed from the number of submissions in each year to the e-print archives in this category. The following sections discuss the growth of citations to the 'hep-ph' e-print archives, frequency of citations, sources citing, and citing authors and countries in the affiliation of the citing authors as per *Science Citation Index* (1991-2002).

5.3.1 Growth of Citations

Among the total of 35420 e-print archives submitted to the 'hep-ph' category, 13928 e-prints (39.32 %) have cited at least once as per *Science Citation Index* (1991-2002). On an average of 34.60 % of the 'hep-ph' e-print archives are cited at least once per year. The number of e-print archives cited once versus the number of submissions in each year from 1992 to 2002 is presented in Figure 20.

5.3.2 Frequency of Citations

Number of citations received to any scientist or any article or any journal is treated as one of the qualitative assessment criteria of the entity studied. Many rewards and appreciations are based on the number of citations received. As the popularity of the e-print archives are increasing, the acceptance of e-print archives is evident from the number of citations received to them. When the number of citations is considered as the income of the e-print archives, the Lorenz Curve for the same is shown in Figure 21. Gini's Coefficient was computed for the category and found 0.70.

5.3.3 Highly Cited E-Print Archives

The average number of citations to the 'hep-ph' e-print archives of LANL (1994-2002) was 3.18. Table 11 gives a list of ten highly cited the 'hep-ph' e-print archives with the name of author(s), title, comments, published sources etc. The citations received to these e-print archives as per *Science Citation Index* (1991 – 2002) in case they are published in a formal source are also documented. Figure 22 depicts the year-wise citing pattern of top ten highly cited e-print archives, shows that more than 58.58 % of the citations are received with in two years after the submission. The highly cited e-print archive 'hep-ph/9811448' has almost equal distribution of

citations in each citing year with no immediacy impact. The ‘he-ph/0002297’ has the highest immediacy impact.

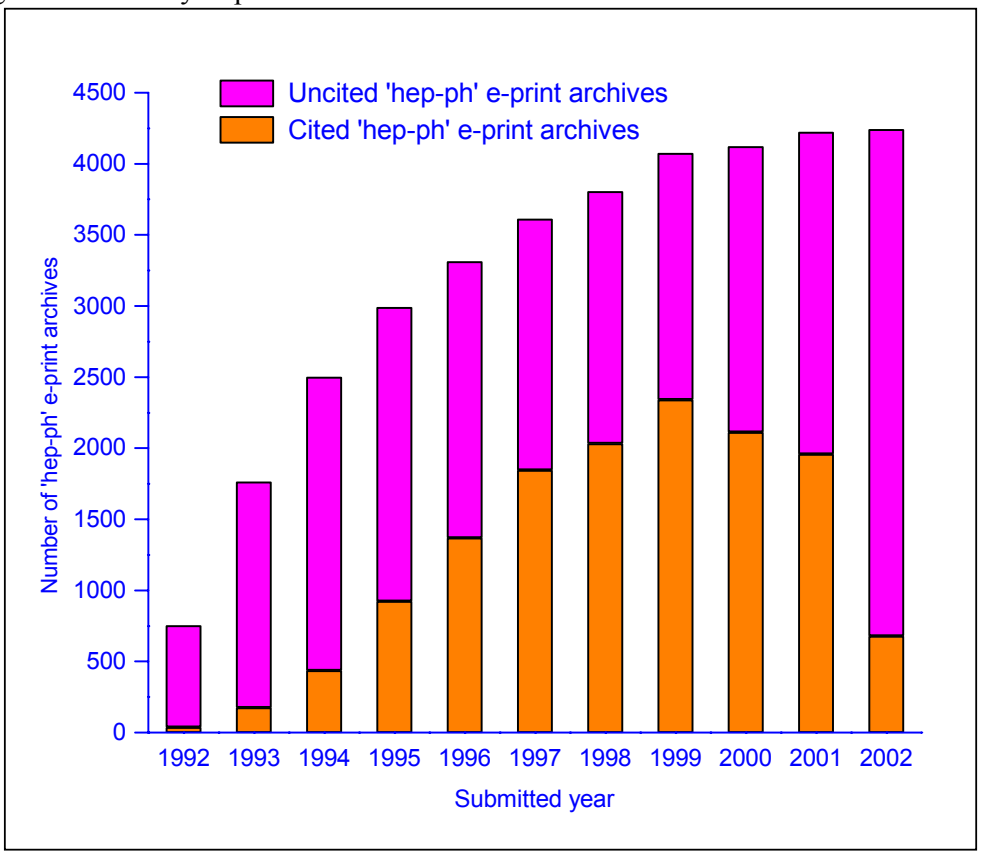

Figure 20: Number of the ‘hep-ph’ e-print archives of LANL (1992-2002) cited at least once and uncited as per *Science Citation Index* (1991 – 2002)

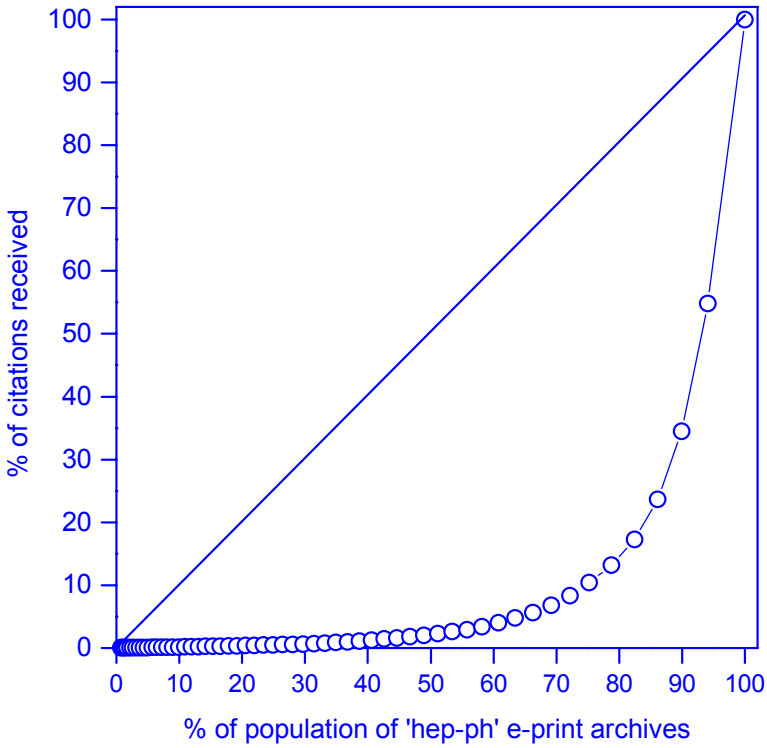

Figure 21: Lorenz curve showing the distribution of citations received to the ‘hep-ph’ e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

Table 11: Highly cited ten 'hep-ph' e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

E-Print archive	Title, Author(s), Comments, Published source etc.	Citations received		
		Before publishing	Before publishing	Total
hep-ph/9801271	Theories with Gauge-Mediated Supersymmetry Breaking Authors: G.F. Giudice, R. Rattazzi Comments: Several minor changes; new appendix with complete analytical formulae for the mass spectrum in gauge mediation at the next-to-leading order Journal-ref: Phys.Rept. 322 (1999) 419-499	76	97	173
hep-ph/9707435	An Introduction to Explicit R-Parity Violation Authors: Herbi Dreiner (Rutherford Laboratory) Comments: 18 pages, LaTex. Requires AXODRAW.STY and SPROCL.STY. To be published in "Perspectives on Supersymmetry", Edited by G.L. Kane, World Scientific. Reference added	81	89	170
hep-ph/9811448	Neutrino Masses from Large Extra Dimensions Authors: Nima Arkani-Hamed, Savas Dimopoulos, Gia Dvali, John March-Russell Comments: 17 pages, latex Report-no: SLAC-PUB-8014, SU-ITP-98/64 Journal-ref: Phys.Rev. D65 (2002) 024032	125	27	152
hep-ph/9806471	Weak Hamiltonian, CP Violation and Rare Decays Authors: Andrzej J. Buras Comments: Les Houches Lectures, to appear in ``Probing the Standard Model of Particle Interactions", F. David and R. Gupta, eds, Elsevier Science B.V. ; 250 pages, 35 figures, 4 latex files Report-no: TUM-HEP-316/98	65	65	130
hep-ph/9808293	Neutrinos on Earth and in the Heavens Authors: Howard Georgi, S.L. Glashow Comments: 7 pages, harvmac, minor changes and new references in revised version Report-no: HUTP-98/A060 Journal-ref: Phys.Rev. D61 (2000) 097301	63	60	123
hep-ph/9811353	New origin for approximate symmetries from distant breaking in extra dimensions Authors: Nima Arkani-Hamed, Savas Dimopoulos Comments: 29 pages, latex Report-no: SLAC-PUB-8008, SU-ITP-98/62 Journal-ref: Phys.Rev. D65 (2002) 052003	79	16	95
hep-ph/9708483	A study of the scenario with nearly degenerate Majorana neutrinos Author: Francesco Vissani Comments: revtex, aps and epsfig styles, 9 pages, 1 figure included	88	No publication details	88
hep-ph/0002297	The Cosmological Constant From The Viewpoint Of String Theory Authors: Edward Witten Comments: 12 pp., Lecture at DM2000, new reference and more conservative scenario added	79	1	80
hep-ph/9810232	Report of the GDR working group on the R-parity violation Authors: R.Barbier, C.Berat, M.Besancon (convenor), P.Binetruy, G.Bordes, F.Brochu, P.Bruel, F.Charles, C.Charlot, M.Chemtob, P.Coyle, M.David, E.Dudas (convenor), D.Fouchez, C.Grojean, M.Jacquet, S.Katsanevas, S.Lavignac, F.Ledroit, R.Lopez, A.Mirea, G.Moreau, C.Mulet-Marquis, E.Nagy, F.Naraghi, R.Nicolaidou, P.Paganini, E.Perez, G.Sajot, C.A.Savoy, Y.Sirois, C.Vallee Comments: 60 pages, LaTeX, 22 figures, 2 tables	79	No publication details	79
hep-ph/9709356	A Supersymmetry Primer Authors: Stephen P. Martin Comments: 102 pages, LaTeX with sprocl.sty, figures embedded with psfig.sty	77	No publication details	77

5.3.4 Highly Citing Sources

The sources citing the 'hep-ph' e-print archives are all journal articles. The total number of journals citing the 'hep-ph' e-print archives as per *Science Citation Index*

(1991-2002) was 121. Table 12 lists the citing journals with the number of times cited, and Corresponding Impact Factors. In case of an article is citing more than one e-print archives, then the number of times cited by the journal is counted as one. The average Impact Factor (IF) of these journals is 2.41 (Impact Factors of eight journals could not be identified). Figure 23 depicted the relation between the number of times cited and the corresponding Impact Factors of these journals. There are a lot of variations in the pattern.

The frequently citing five journals are *Physical Review D* (3544 times) followed by *Physics Letters B* (3078 times), *Nuclear Physics B* (1283 times), *Nuclear Physics B - Proceedings Supplements* (1026 times), and *Physical Review Letters* (672 times). The citing pattern of these five journals is depicted in Figure 24.

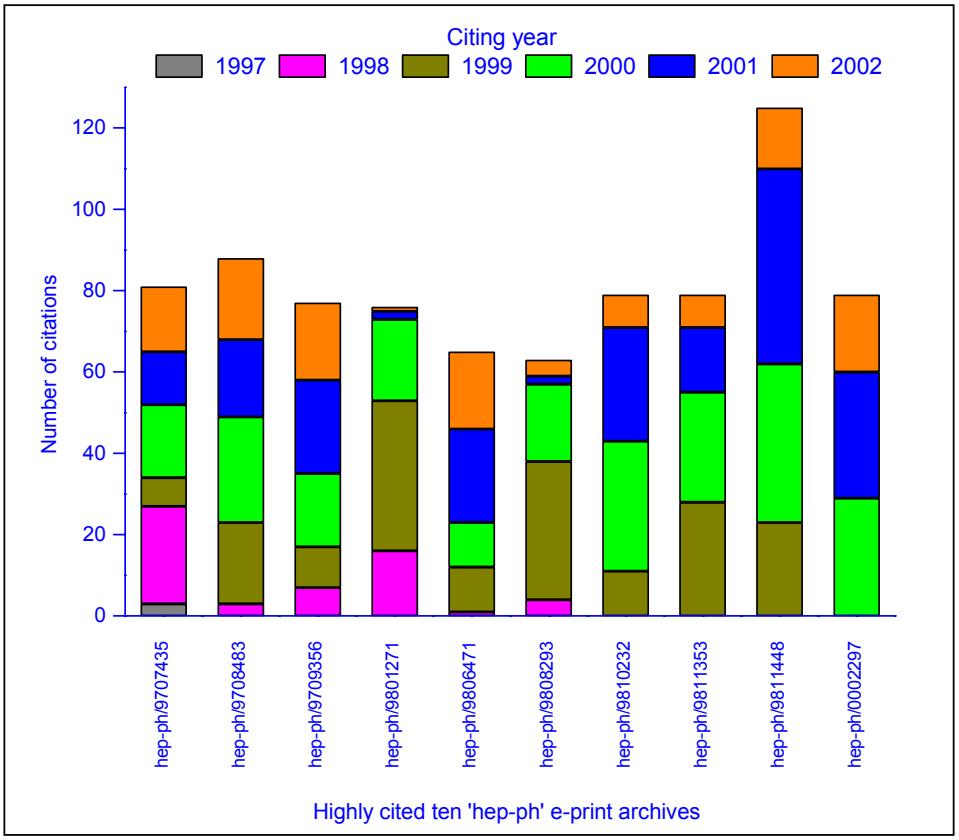

Figure 22: Citing pattern of highly cited ten 'hep-ph' e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

Table 12: Journals citing the 'hep-ph' e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

Citing journal	Impact Factor	Number of times cited
PHYSICAL REVIEW D	4.363	3544
PHYSICS LETTERS B	4.377	3078
NUCLEAR PHYSICS B	6.226	1283
NUCLEAR PHYSICS B-PROCEEDINGS SUPPLEMENTS	0.947	1026
PHYSICAL REVIEW LETTERS	6.668	672
NUCLEAR PHYSICS A	2.074	644
EUROPEAN PHYSICAL JOURNAL C	5.194	571
PHYSICAL REVIEW C	2.695	380
ACTA PHYSICA POLONICA B	0.574	365
INTERNATIONAL JOURNAL OF MODERN PHYSICS A	1.541	349
JOURNAL OF PHYSICS G	1.182	333
MODERN PHYSICS LETTERS A	1.119	290
PHYSICS OF ATOMIC NUCLEI	0.463	224
JOURNAL OF HIGH ENERGY PHYSICS	8.664	136
PROGRESS OF THEORETICAL PHYSICS	1.681	133
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A	1.026	114
PHYSICS REPORTS-REVIEW SECTION OF PHYSICS LETTERS	8.341	98
CLASSICAL AND QUANTUM GRAVITY	2.041	90
PRAMANA-JOURNAL OF PHYSICS	0.283	84
EUROPEAN PHYSICAL JOURNAL A	1.725	79
PROGRESS IN PARTICLE AND NUCLEAR PHYSICS	2.084	71
ZEITSCHRIFT FUR PHYSIK C-PARTICLES AND FIELDS	NA	66
COMMUNICATIONS IN THEORETICAL PHYSICS	0.397	59
COMPUTER PHYSICS COMMUNICATIONS	1.082	50
ANNALS OF PHYSICS	1.968	47
CZECHOSLOVAK JOURNAL OF PHYSICS	0.345	46
JETP LETTERS	1.377	45
ASTROPHYSICAL JOURNAL	5.921	43
PROGRESS OF THEORETICAL PHYSICS SUPPLEMENT	0.635	43
ANNUAL REVIEW OF NUCLEAR AND PARTICLE SCIENCE	6.69	32
PHYSICA SCRIPTA	0.772	32
PHYSICAL REVIEW A	2.810	31
CHINESE JOURNAL OF PHYSICS	0.365	29
THEORETICAL AND MATHEMATICAL PHYSICS	0.600	27
JOURNAL OF PHYSICS A	1.542	26
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA A	0.697	24
REVIEWS OF MODERN PHYSICS	12.762	24
CHINESE PHYSICS LETTERS	0.813	23
JOURNAL OF MATHEMATICAL PHYSICS	1.151	23
JOURNAL OF THE KOREAN PHYSICAL SOCIETY	0.505	23
INTERNATIONAL JOURNAL OF THEORETICAL PHYSICS	0.520	22
FORTSCHRITTE DER PHYSIK-PROGRESS OF PHYSICS	1.043	20
GENERAL RELATIVITY AND GRAVITATION	0.773	20
JOURNAL OF EXPERIMENTAL AND THEORETICAL PHYSICS	1.156	20
ZEITSCHRIFT FUR PHYSIK A-HADRONS AND NUCLEI	NA	20
PHYSICAL REVIEW E	2.235	18
INTERNATIONAL JOURNAL OF MODERN PHYSICS D	1.242	16
PHYSICAL REVIEW B	3.070	16
REPORTS ON PROGRESS IN PHYSICS	8.879	16
ASTRONOMY & ASTROPHYSICS	2.281	15
ASTROPARTICLE PHYSICS	4.110	15
REVISTA MEXICANA DE FISICA	0.154	15
EUROPHYSICS LETTERS	2.304	14
FOUNDATIONS OF PHYSICS	0.425	14
PHYSICS LETTERS A	1.220	14

Citing journal	Impact Factor	Number of times cited
FEW-BODY SYSTEMS	1.857	11
INTERNATIONAL JOURNAL OF MODERN PHYSICS B	0.523	11
RIVISTA DEL NUOVO CIMENTO	1.333	11
SPRINGER TRACTS IN MODERN PHYSICS	0.446	11
USPEKHI FIZICHESKIKH NAUK	NA	11
SPACE SCIENCE REVIEWS	1.601	10
JOURNAL OF PHYSICS B	2.046	9
ANNALEN DER PHYSIK	1.590	8
HYPERFINE INTERACTIONS	0.634	8
MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY	4.681	8
AUSTRALIAN JOURNAL OF PHYSICS	0.657	7
CHAOS SOLITONS & FRACTALS	0.839	7
PHYSICA A	1.295	7
LETTERS IN MATHEMATICAL PHYSICS	0.819	6
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA B	0.331	6
PHYSICS-USPEKHI	NA	6
ASTROPHYSICS AND SPACE SCIENCE	0.274	5
CURRENT SCIENCE	0.600	5
HELVETICA PHYSICA ACTA	0.520	5
NATURE	27.955	5
PHYSICS TODAY	4.790	5
COMMUNICATIONS IN MATHEMATICAL PHYSICS	1.729	4
IZVESTIYA AKADEMII NAUK SERIYA FIZICHESKAYA	0.088	4
JOURNAL OF LOW TEMPERATURE PHYSICS	0.954	4
PHILOSOPHICAL TRANS. OF THE ROYAL SOCIETY OF LONDON SERIES A	1.471	4
AMERICAN JOURNAL OF PHYSICS	0.620	3
ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES	5.214	3
CANADIAN JOURNAL OF PHYSICS	0.623	3
CONTEMPORARY PHYSICS	2.300	3
FOUNDATIONS OF PHYSICS LETTERS	0.380	3
INTERNATIONAL JOURNAL OF MODERN PHYSICS C	0.728	3
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION B	1.041	3
ADVANCES IN NUCLEAR PHYSICS	6.667	2
ADVANCES IN SPACE RESEARCH	0.462	2
ASTRONOMY LETTERS-A	1.015	2
COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE IV	0.244	2
EUROPEAN PHYSICAL JOURNAL B	1.811	2
JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN	1.628	2
PHYSICA E	1.009	2
PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE USA	10.896	2
ACTA ASTRONOMICA	2.377	1
ANNALS OF THE NEW YORK ACADEMY OF SCIENCES	1.593	1
ASTRONOMY & ASTROPHYSICS SUPPLEMENT SERIES	NA	1
CHAOS	1.935	1
EUROPEAN PHYSICAL JOURNAL D	1.583	1
FUSION SCIENCE AND TECHNOLOGY	NA	1
IAU SYMPOSIA	NA	1
INFORMATION SCIENCES	0.264	1
INSTRUMENTS AND EXPERIMENTAL TECHNIQUES	0.265	1
INTERNATIONAL JOURNAL OF QUANTUM CHEMISTRY	1.249	1
JOURNAL OF ASTROPHYSICS AND ASTRONOMY	0.175	1
JOURNAL OF COMPUTATIONAL PHYSICS	1.716	1
JOURNAL OF STATISTICAL PHYSICS	1.241	1
MEASUREMENT SCIENCE & TECHNOLOGY	0.859	1
NEW ASTRONOMY	2.348	1
NONLINEARITY	1.159	1
PHYSICA B	0.663	1

Citing journal	Impact Factor	Number of times cited
PHYSICA C	0.806	1
PLASMA PHYSICS AND CONTROLLED FUSION	1.910	1
PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON SERIES A	1.188	1
RADIATION PROTECTION DOSIMETRY	0.768	1
SCIENCE	23.329	1
SCIENCE IN CHINA SERIES A	0.340	1
SPECTROCHIMICA ACTA PART A	0.838	1
ZEITSCHRIFT FUR NATURFORSCHUNG SECTION A	0.746	1
ZEITSCHRIFT FUR PHYSIK D	NA	1

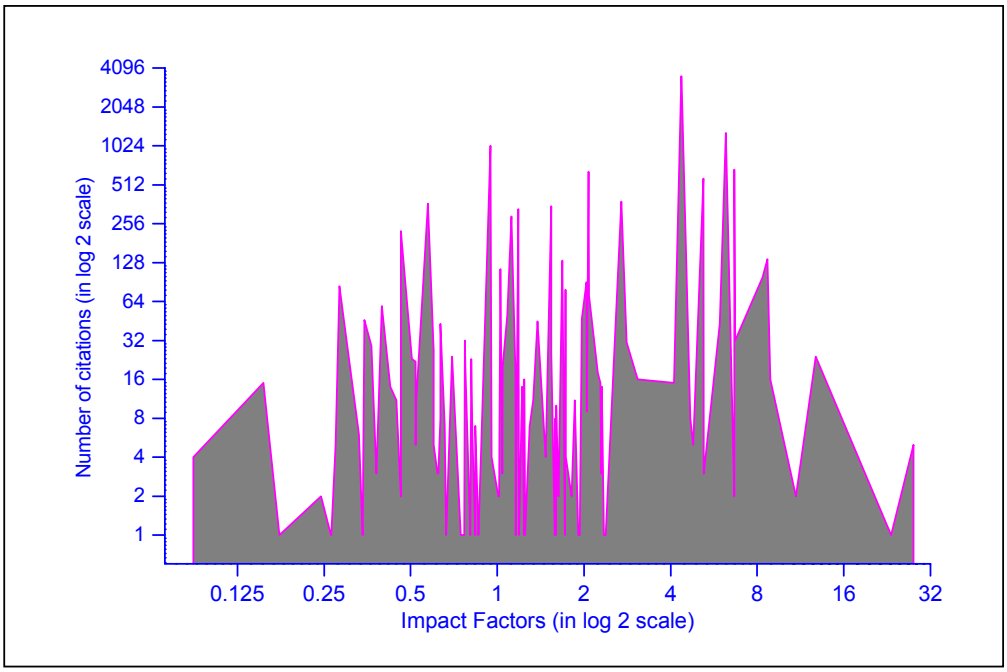

Figure 23: Relationship between the number of times cited and the corresponding Impact Factors of journals citing the 'hep-ph' e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991 – 2002)

5.3.5 Highly Citing Authors and Countries

There are 12486 individual authors cited the 'hep-ph' e-print archives as per *Science Citation Index* during 1991-2002. Among the top citing authors, Ellis, J. comes first with 88 times cited followed by Banerjee, S. (82 times), Mohapatra, R.N. (72 times), Valle, J.W.F. (63 times), and Yanagida, T. (62 times). Table 13 documents the authors citing the 'hep-ph' e-print archives with the corresponding number of times cited. The number of authors citing the 'hep-ph' e-print archives is increasing year-by-year. The average percentage growth in number of authors citing e-print archives is 138.20 %. The year-wise growth pattern of authors citing the 'hep-ph' e-print archives as per *Science Citation Index* (1991-2002) is presented in Figure 25. Lotka's Law for the publication productivity has been applied to the information use by

researchers in the form of citing the 'hep-ph' e-print archives. The graphical representation of the same is depicted in Figure 26.

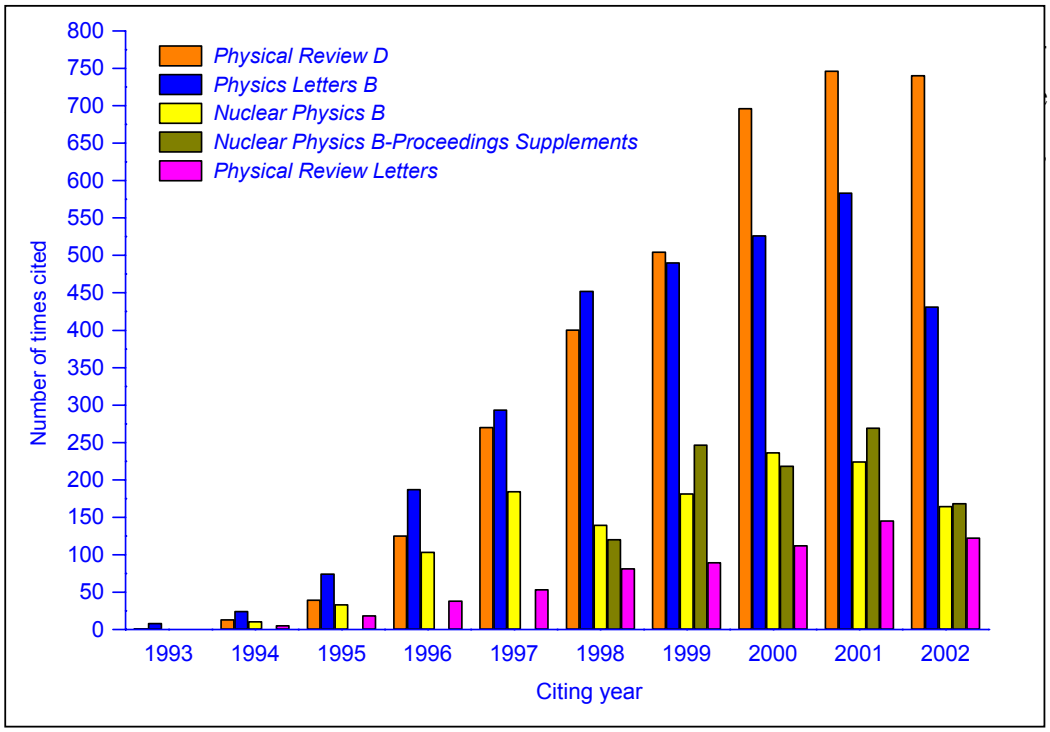

Figure 24: Citing pattern of highly citing five journals of 'hep-ph' e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

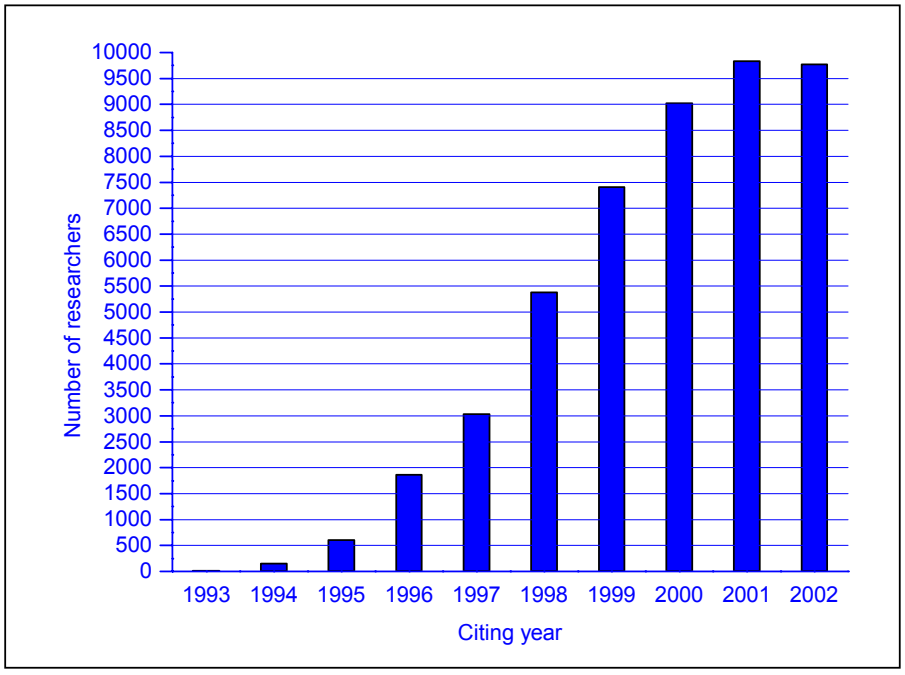

Figure 25: Number of researchers citing the 'hep-ph' e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

Table 13: Authors citing the 'hep-ph' archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

Citing author	No. of times cited	Citing author	No. of times cited	Citing author	No. of times cited
Ellis-J	88	Faessler-A	32	Lisi-E	29
Banerjee-S	82	Ji-XD	32	Pokorski-S	29
Mohapatra-RN	72	Murayama-H	32	Quiros-M	29
Valle-JWF	63	Ryskin-MG	32	Rajagopal-K	29
Yanagida-T	62	Strikman-M	32	Savage-MJ	29
Schafer-A	59	Wells-JD	32	Schmidt-I	29
Datta-A	58	Zahed-I	32	Yamaguchi-M	29
Riotto-A	58	Aguilarbenitez-M	31	Albrow-MG	28
Barger-V	55	Alexander-G	31	Arisawa-T	28
Thomas-AW	55	Anderhub-H	31	Asakawa-T	28
Klapdorkleingrothaus-HV	54	Andreev-VP	31	Ashmanskas-W	28
Greiner-W	53	Azuelos-G	31	Azemoon-T	28
Stocker-H	51	Dutta-B	31	Aziz-T	28
King-SF	48	Foot-R	31	Bagnaia-P	28
Ma-E	46	Kane-GL	31	Baksay-L	28
Anselmo-F	45	Shafi-Q	31	Barnes-VE	28
Olive-KA	44	Strumia-A	31	Bellagamba-L	28
Han-T	43	Akimoto-H	30	Choudhury-D	28
Martin-AD	43	Allaby-J	30	Goeke-K	28
Dvali-G	42	Arefiev-A	30	Kwiecinski-J	28
Soni-A	42	Arnoud-Y	30	Li-XQ	28
Kobayashi-T	41	Boyanovsky-D	30	Lola-S	28
Nanopoulos-DV	40	Haba-N	30	Melnikov-K	28
Smirnov-AY	40	Kakushadze-Z	30	Polyakov-MV	28
Xing-ZZ	40	Levin-E	30	Repond-J	28
Hollik-W	39	Martinelli-G	30	Rizzo-TG	28
He-XG	38	Nomura-Y	30	Savci-M	28
Kim-CS	38	Abe-K	29	Song-HS	28
Sarkar-U	37	Adriani-O	29	Volkas-RR	28
Babu-KS	36	Alemanni-G	29	Wetterich-C	28
Feng-JL	36	Allison-J	29	Wilczek-F	28
Meissner-UG	36	Alviggi-MG	29	Apel-WD	27
Yuan-CP	35	Amidei-D	29	Azzibacchetta-P	27
Baer-H	34	Anderson-KJ	29	Bari-G	27
Li-HN	34	Antos-J	29	Belyaev-A	27
Roy-DP	34	Apollinari-G	29	Cheng-HY	27
Whisnant-K	34	Arcelli-S	29	Csaki-C	27
Amato-S	33	Asai-S	29	Devega-HJ	27
Brodsky-SJ	33	Axen-D	29	Dumitru-A	27
Debarbaro-P	33	Bacchetta-N	29	Magill-S	27
Djouadi-A	33	Barbarogaltieri-A	29	Pospelov-M	27
Gonzalezgarcia-MC	33	Barberio-E	29	Wang-XN	27
Huang-CS	33	Barlow-RJ	29	Yuan-F	27
Nath-P	33	Basile-M	29	Abbiendi-G	26
Ross-GG	33	Behnke-T	29	Adam-W	26
Simonov-YA	33	Bella-G	29	Allport-PP	26
Alcaraz-J	32	Bell-KW	29	Amaldi-U	26
Alemany-R	32	Czarnecki-A	29	Andreazza-A	26
Aliev-TM	32	Diehl-M	29	Antilogus-P	26
Aloisio-A	32	Giunti-C	29	Antonioli-P	26
Belitsky-AV	32	Heinz-U	29	Arkanihamed-N	26
Drees-M	32	Khalil-S	29	Asman-B	26

Citing author	No. of times cited
Ball-AH	26
Bass-SA	26
Boscherini-D	26
Bruni-A	26
Chao-KT	26
Du-DS	26
Faraggi-AE	26
Grimus-W	26
Hagiwara-K	26
Krakauer-D	26
Leontaris-GK	26
Lyth-DH	26
Mankiewicz-L	26
Matchev-KT	26
Miller-GA	26
Musgrave-B	26
Nunokawa-H	26
Pilaftsis-A	26
Stirling-WJ	26
Tanimoto-M	26
Tata-X	26
Wagner-CEM	26
Zakharov-VI	26
Abreu-P	25
Achard-P	25
Adye-T	25
Akopian-A	25
Alekseev-GD	25
Almehed-S	25
Bruni-G	25
Cheung-K	25
Cifarelli-L	25
Dimopoulos-S	25
Ebert-D	25
Fogli-GL	25
Frampton-PH	25
Kang-SK	25
Lee-JS	25
Maltman-K	25
Peschanski-R	25
Petcov-ST	25
Romeo-GC	25
Silvestrini-L	25
Yoshida-R	25
Abbott-B	24
Ackerstaff-K	24
Ambrosi-G	24
Angelescu-T	24
Atwood-D	24
Carena-M	24
Chun-EJ	24
Gyulassy-M	24
Kawasaki-M	24
Mattingly-MCK	24

Citing author	No. of times cited
Mukhopadhyaya-B	24
Muller-D	24
Perezlorenzana-A	24
Pisarski-RD	24
Reinhardt-H	24
Toki-H	24
Weigel-H	24
Zerwas-PM	24
Acciarri-M	23
Acharya-BS	23
Altarelli-G	23
Azfar-F	23
Batley-JR	23
Bentvelsen-S	23
Buras-AJ	23
Close-FE	23
Frank-M	23
Gatto-R	23
Grossman-Y	23
Hirsch-M	23
Huang-T	23
Kharzeev-D	23
Laine-M	23
Linde-A	23
Masiero-A	23
Renard-FM	23
Rho-M	23
Rummukainen-K	23
Schafer-T	23
Authors citing 22 times	40
Authors citing 21 times	37
Authors citing 20 times	33
Authors citing 19 times	46
Authors citing 18 times	44
Authors citing 17 times	63
Authors citing 16 times	56
Authors citing 15 times	63
Authors citing 14 times	69
Authors citing 13 times	62
Authors citing 12 times	122
Authors citing 11 times	135
Authors citing ten times	155
Authors citing nine times	170
Authors citing eight times	225
Authors citing seven times	323
Authors citing six times	433
Authors citing five times	544
Authors citing four times	668
Authors citing three times	1068
Authors citing two times	2084
Authors citing only once	5807

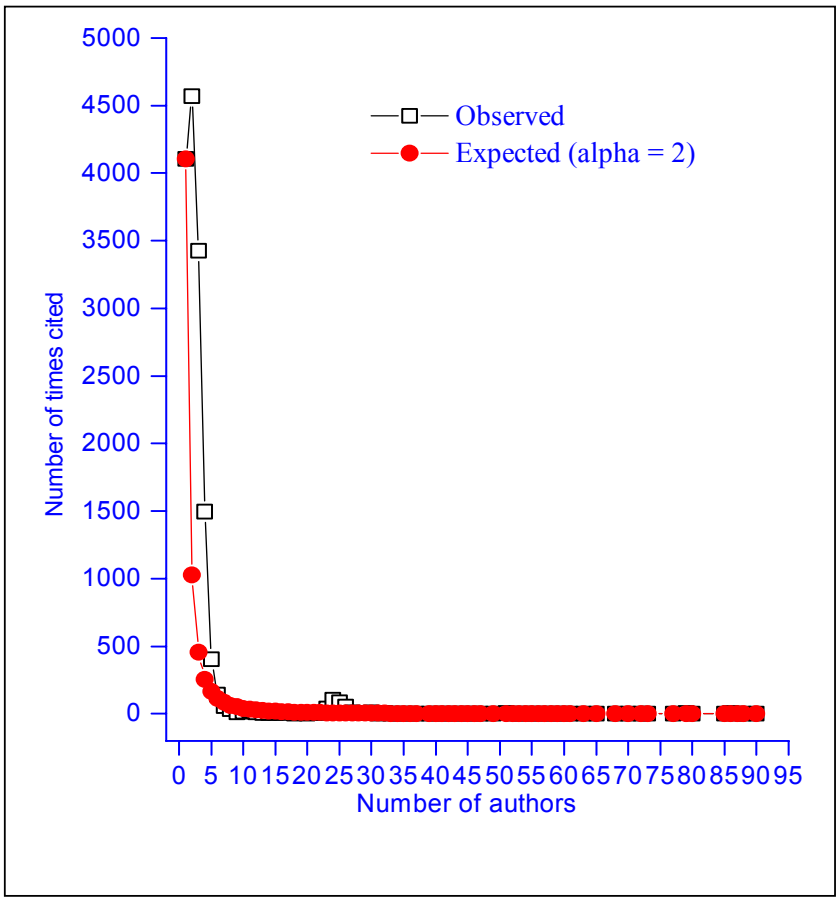

Figure 26: Lotka's Law applied to information use by authors citing the 'hep-ph' e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

Table 14: Countries in the affiliation of the citing authors of the 'hep-ph' e-print archives of LANL (1992-2002) as per *Science Citation Index* (1991-2002)

Citing Country	Number of occurence	%
USA	11678	26.69
ITALY	4999	11.43
GERMANY	4151	9.49
JAPAN	2447	5.59
RUSSIA	2098	4.80
ENGLAND	2027	4.63
FRANCE	1901	4.35
SWITZERLAND	1761	4.03
PEOPLES-R-CHINA	1223	2.80
SPAIN	1210	2.77
CANADA	1012	2.31
SOUTH-KOREA	851	1.95
POLAND	831	1.90
INDIA	827	1.89
BRAZIL	531	1.21
NETHERLANDS	505	1.15
ISRAEL	478	1.09
TAIWAN	465	1.06
GREECE	360	0.82
FINLAND	329	0.75
AUSTRALIA	324	0.74
SWEDEN	280	0.64
HUNGARY	271	0.62
MEXICO	268	0.61
PORTUGAL	246	0.56
DENMARK	228	0.52
AUSTRIA	222	0.51
BELGIUM	217	0.50
SCOTLAND	167	0.38
CZECH-REPUBLIC	160	0.37
SLOVENIA	143	0.33
ARGENTINA	140	0.32
UKRAINE	137	0.31
TURKEY	119	0.27
NORWAY	105	0.24
SLOVAKIA	99	0.23
ROMANIA	93	0.21
REP-OF-GEORGIA	82	0.19
BULGARIA	80	0.18
CHILE	67	0.15
CROATIA	62	0.14
COLOMBIA	58	0.13
ARMENIA	52	0.12
EGYPT	45	0.10
WALES	43	0.10
CYPRUS	39	0.09
IRAN	35	0.08
IRELAND	33	0.08
MOROCCO	26	0.06
SOUTH-AFRICA	26	0.06
BYELARUS	22	0.05
ECUADOR	20	0.05
PAKISTAN	17	0.04
ESTONIA	16	0.04
AZERBAIJAN	13	0.03
URUGUAY	13	0.03
KAZAKHSTAN	11	0.03
VENEZUELA	11	0.03
UZBEKISTAN	9	0.02
VIETNAM	9	0.02
JORDAN	7	0.02
NEW-ZEALAND	6	0.01
INDONESIA	4	0.01
PERU	4	0.01
YUGOSLAVIA	4	0.01
SAUDI-ARABIA	3	0.01
SINGAPORE	3	0.01
ALGERIA	2	0.00
BANGLADESH	2	0.00
BOSNIA-&-HERCEG	2	0.00
COSTA-RICA	2	0.00
CUBA	2	0.00
HONG-KONG	2	0.00
MOLDOVA	2	0.00
SRI-LANKA	2	0.00
SYRIA	2	0.00
BENIN	1	0.00
ETHIOPIA	1	0.00
ICELAND	1	0.00
KYRGYZSTAN	1	0.00
LEBANON	1	0.00
LIBYA	1	0.00
MONGOL-PEO-REP	1	0.00
TUNISIA	1	0.00
Total	**43749**	**100.00**

5.4 High Energy Physics - Theory (hep-th) E-Print Archives

The 'hep-th' e-print archives of LANL are for string/conformal/field theory preprints started from August 14, 1991 (http://www.arxiv.org/list/hep-th/info). There were a total of 29140 e-prints are submitted to this category till 2002. An upward growth can be observed from the number of submissions in each year to the e-print archives in this category. The following sections discuss the growth of citations to the 'hep-th' e-print archives, frequency of citations, sources citing, and citing authors and countries in the affiliation of the citing authors as per *Science Citation Index* (1991-2002).

5.4.1 Growth of Citations

Among the total of 29140 e-print archives submitted to the 'hep-th' category, 13639 e-prints (46.81 %) have cited at least once as per *Science Citation Index* (1991-2002). On an average of 43.41 % of the 'hep-th' e-print archives are cited at least once per year. The number of e-print archives cited versus the number of submissions in each year from 1994 to 2002 is presented in Figure 27.

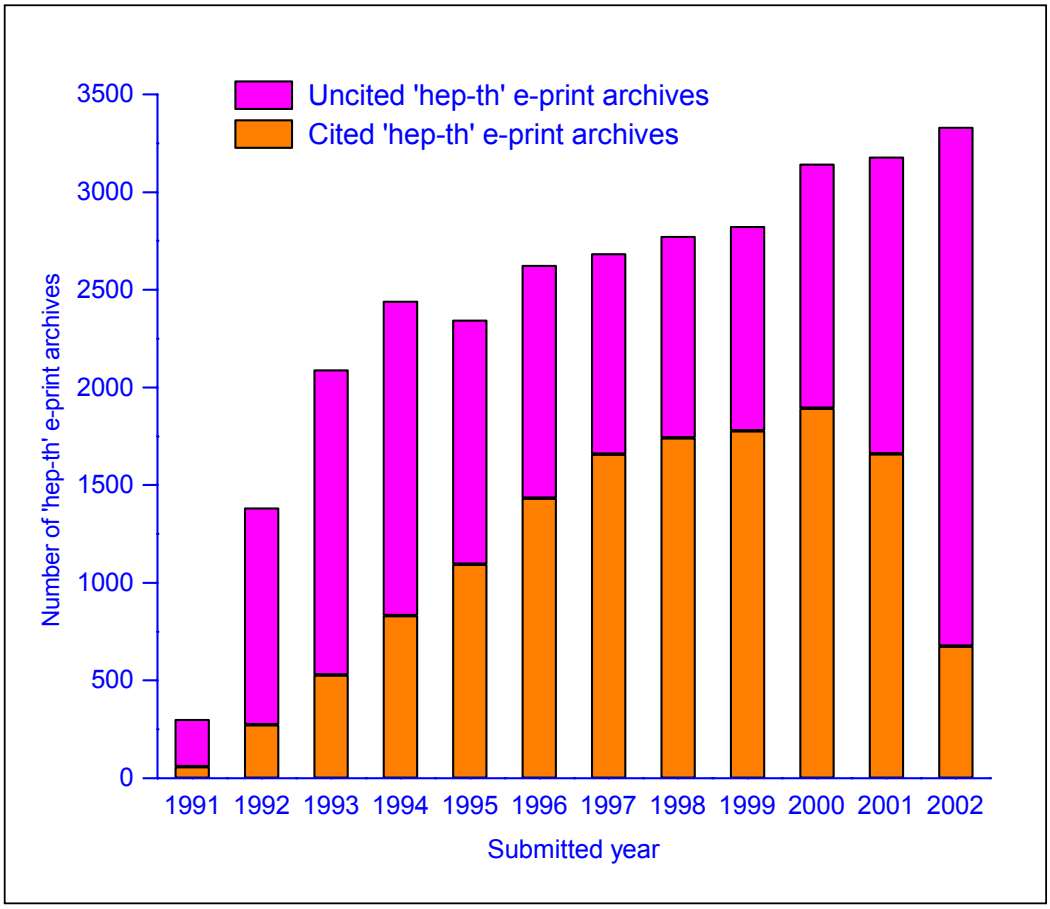

Figure 27: Number of the 'hep-th' e-print archives of LANL (1991-2002) cited at least once and uncited as per *Science Citation Index* (1991 – 2002)

5.4.2 Frequency of Citations

It is presumed that a frequently cited e-print archive is notable, seminal, and/or innovative. However, many variables in addition to scientific merit determine citation frequency. The study has considered citations to e-print archives are the income to each e-print archives, then Lorenz Curve for the 'hep-th' e-print archives are depicted in Figure 28. Gini's Coefficient has calculated and is found 0.68.

5.4.3 Highly Cited E-Print Archives

The average number of citations to the 'hep-th' e-print archives of LANL (1994-2002) is 4.70. Table 15 gives a list of ten highly cited the 'hep-ph' e-print archives with the name of author(s), title, comments, published sources etc. The number of citations to the corresponding e-print archives as per *Science Citation Index* (1991-2002) in case that is published in a formal source is also documented. Figure 29 depicts the year-wise citing pattern of top ten highly cited e-print archives, shows that more than 66.88 % of the citations are received with in two years after the submission. The highly cited e-print archive 'hep-th/9611050' has almost equal distribution of citations in each citing years with no immediacy impact. The highest immediacy impact was observed for 'hep-th/9802150'.

5.4.4 Highly Citing Sources

The sources citing the 'hep-th' e-print archives are all journal articles. The total number of journals citing the 'hep-th' e-print archives as per *Science Citation Index* (1991-2002) was 185. Table 16 lists the citing journals with the number of times cited, and corresponding Impact Factors. In case an article is citing more than one e-print archives, then the number of times cited for that journal is counted as one. The average Impact Factor (IF) of these journals is 1.85 (Impact Factors of nine journals could not be identified). The number of times cited and the corresponding Impact Factors of these journals are presented in Figure 30. A lot of variation can be observed.

The frequently citing five journals are *Nuclear Physics B* (2841 times) followed by *Physics Letters B* (2625 times), *Physical Review D* (2098 times), *Classical and Quantum Gravity* (593 times), and *Modern Physics Letters A* (564 times). The citing pattern of these five journals is depicted in Figure 31.

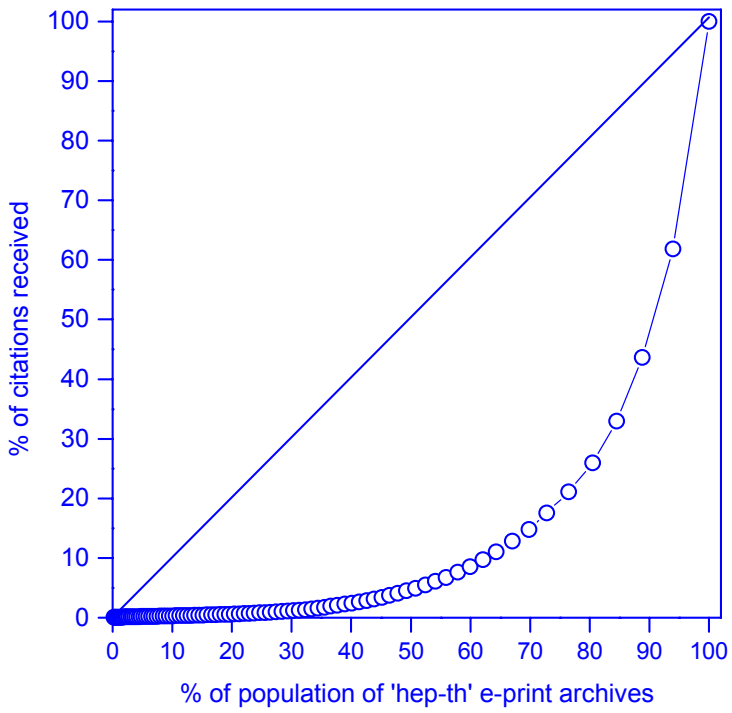

Figure 28: Lorenz curve showing the distribution of citations received to the 'hep-th' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

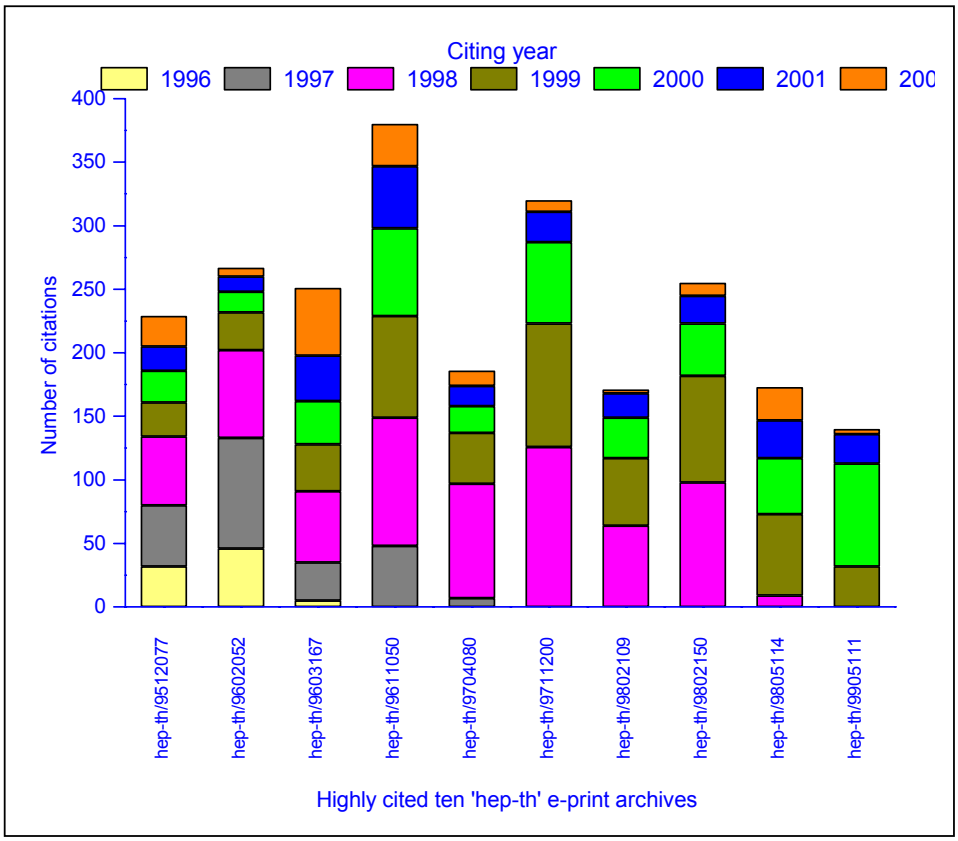

Figure 29: Citing pattern of highly cited ten 'hep-th' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Table 15: Highly cited ten 'hep-th' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

E-Print archive	Title, Author(s), Comments, Published source etc.	Citations received		
		Before publishing	Before publishing	Total
hep-th/9711200	The Large N Limit of Superconformal Field Theories and Supergravity Authors: Juan M. Maldacena Comments: 20 pages, harvmac, v2: section on AdS_2 corrected, references added, v3: More references and a sign in eqns 2.8 and 2.9 corrected Report-no: HUTP-98/A097 Journal-ref: Adv.Theor.Math.Phys. 2 (1998) 231-252; Int.J.Theor.Phys. 38 (1999) 1113-1133	320	1264	1584
hep-th/9802150	Anti De Sitter Space And Holography Author: Edward Witten Comments: 40 pp.; additional references and assorted corrections Journal-ref: Adv.Theor.Math.Phys. 2 (1998) 253-291	255	888	1143
hep-th/9802109	Gauge Theory Correlators from Non-Critical String Theory Authors: S.S. Gubser, I.R. Klebanov, A.M. Polyakov Comments: 15 pages, harvmac with btxmac; minor revisions, 1 reference added, the version to appear in Physics Letters B Report-no: PUPT-1767 Journal-ref: Phys.Lett. B428 (1998) 105-114	171	862	1033
hep-th/9905111	Large N Field Theories, String Theory and Gravity Authors: O. Aharony, S.S. Gubser, J. Maldacena, H. Ooguri, Y. Oz Comments: 261 pages, 42 post-script figures. Please send any comment to jmaldac@fas.harvard.edu. v2: added references and small corrections. v3: minor changes and corrected discussion of SU(3)-invariant supergravity solution Report-no: CERN-TH/99-122, HUTP-99/A027, LBNL-43113, RU-99-18, UCB-PTH-99/16 Journal-ref: Phys.Rept. 323 (2000) 183-386	140	315	455
hep-th/9611050	TASI Lectures on D-Branes Authors: Joseph Polchinski Comments: 63 Pages, LaTeX, 13 epsf figures, TASI96(d-branes) Small corrections and clarifications. More complete list of early references in section 1.1 Report-no: NSF-ITP-96-145	380	25	405
hep-th/9602052	Notes on D-Branes Authors: Joseph Polchinski, Shyamoli Chaudhuri, Clifford V. Johnson Comments: Small number of typos corrected and references added Picture-changing argument correctly attributed to Bianchi-Pradisi-Sagnotti 45 pages (harvmac b); figures require epsf.tex Report-no: NSF-ITP-96-003	267	41	308
hep-th/9603167	D-branes, Quivers, and ALE Instantons Authors: Michael R. Douglas, Gregory Moore Comments: 50 pages, 11 figures, harvmac/epsf Report-no: RU-96-15, YCTP-P5-96 Subj-class: High Energy Physics - Theory; Algebraic Geometry	251	1	252
hep-th/9512077	Branes within Branes Author: Michael R. Douglas Comments: harvmac, 10 pp. (References added) Report-no: RU-95-92	229	6	235
hep-th/9704080	Another Conjecture about M(atrix) Theory Author: Leonard Susskind Comments: 15 pages in phyzzx Report-no: SU-ITP-97-11	186	6	192
hep-th/9805114	The Holographic Bound in Anti-de Sitter Space Author: L. Susskind, Edward Witten Comments: 10 pages, phyzzx	173	No publication details	173

Table 16: Journals citing the 'hep-th' e-print archives of LANL (1994-2002) as per *Science Citation Index* (1991-2002)

Citing journal	Impact Factor	Number of times cited
NUCLEAR PHYSICS B	6.226	2841
PHYSICS LETTERS B	4.377	2625
PHYSICAL REVIEW D	4.363	2098
CLASSICAL AND QUANTUM GRAVITY	2.041	593
MODERN PHYSICS LETTERS A	1.119	564
INTERNATIONAL JOURNAL OF MODERN PHYSICS A	1.541	549
JOURNAL OF PHYSICS A-MATHEMATICAL AND GENERAL	1.542	441
JOURNAL OF MATHEMATICAL PHYSICS	1.151	367
JOURNAL OF HIGH ENERGY PHYSICS	8.664	355
PHYSICAL REVIEW LETTERS	6.668	335
NUCLEAR PHYSICS B-PROCEEDINGS SUPPLEMENTS	0.947	331
COMMUNICATIONS IN MATHEMATICAL PHYSICS	1.729	228
PROGRESS OF THEORETICAL PHYSICS	1.681	183
FORTSCHRITTE DER PHYSIK-PROGRESS OF PHYSICS	1.043	157
PHYSICS LETTERS A	1.220	143
THEORETICAL AND MATHEMATICAL PHYSICS	0.600	140
LETTERS IN MATHEMATICAL PHYSICS	0.819	132
ANNALS OF PHYSICS	1.968	118
EUROPEAN PHYSICAL JOURNAL C	5.194	102
GENERAL RELATIVITY AND GRAVITATION	0.773	77
INTERNATIONAL JOURNAL OF THEORETICAL PHYSICS	0.520	69
PHYSICS OF ATOMIC NUCLEI	0.463	66
ACTA PHYSICA POLONICA B	0.574	65
PROGRESS OF THEORETICAL PHYSICS SUPPLEMENT	0.635	61
CZECHOSLOVAK JOURNAL OF PHYSICS	0.345	59
PHYSICS REPORTS-REVIEW SECTION OF PHYSICS LETTERS	8.341	59
COMMUNICATIONS IN THEORETICAL PHYSICS	0.397	54
JOURNAL OF THE KOREAN PHYSICAL SOCIETY	0.505	49
NUCLEAR PHYSICS A	2.074	47
JOURNAL OF GEOMETRY AND PHYSICS	0.769	46
INTERNATIONAL JOURNAL OF MODERN PHYSICS B	0.523	44
JOURNAL OF PHYSICS G-NUCLEAR AND PARTICLE PHYSICS	1.182	44
PHYSICAL REVIEW B	3.070	44
JETP LETTERS	1.377	42
PHYSICAL REVIEW E	2.235	42
CHAOS SOLITONS & FRACTALS	0.839	41
PHYSICAL REVIEW A	2.810	40
ZEITSCHRIFT FUR PHYSIK C-PARTICLES AND FIELDS	NA	32
INTERNATIONAL JOURNAL OF MODERN PHYSICS D	1.242	30
ANNALEN DER PHYSIK	1.590	28
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA B	0.331	26
REVIEWS IN MATHEMATICAL PHYSICS	0.938	25
EUROPHYSICS LETTERS	2.304	24
FOUNDATIONS OF PHYSICS	0.425	22
JOURNAL OF EXPERIMENTAL AND THEORETICAL PHYSICS	1.156	17
JOURNAL OF STATISTICAL PHYSICS	1.241	17
PHYSICAL REVIEW B-CONDENSED MATTER	3.070	15
JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN	1.628	14
PRAMANA-JOURNAL OF PHYSICS	0.283	14
JOURNAL OF ALGEBRA	0.501	13

Citing journal	Impact Factor	Number of times cited
CANADIAN JOURNAL OF PHYSICS	0.623	12
HELVETICA PHYSICA ACTA	0.520	12
PHYSICAL REVIEW C	2.695	12
CHINESE PHYSICS LETTERS	0.813	10
JOURNAL OF DIFFERENTIAL GEOMETRY	0.299	10
PHYSICA A	1.295	10
JOURNAL OF PURE AND APPLIED ALGEBRA	0.428	9
MATHEMATICAL RESEARCH LETTERS	0.632	9
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA A	0.697	9
REVIEWS OF MODERN PHYSICS	12.762	9
ADVANCES IN MATHEMATICS	0.653	8
FOUNDATIONS OF PHYSICS LETTERS	0.380	8
PHYSICAL REVIEW C-NUCLEAR PHYSICS	2.695	8
USPEKHI FIZICHESKIKH NAUK	NA	8
ASTROPHYSICAL JOURNAL	5.921	7
COMPOSITIO MATHEMATICA	0.447	7
JOURNAL OF KNOT THEORY AND ITS RAMIFICATIONS	0.344	7
PHYSICA SCRIPTA	0.772	7
REPORTS ON PROGRESS IN PHYSICS	8.879	7
REVISTA MEXICANA DE FISICA	0.154	7
RUSSIAN MATHEMATICAL SURVEYS	0.363	7
ANNALES HENRI POINCARE	0.919	6
ANNUAL REVIEW OF NUCLEAR AND PARTICLE SCIENCE	6.690	6
CHINESE JOURNAL OF PHYSICS	0.365	6
EUROPEAN PHYSICAL JOURNAL B	1.811	6
INVENTIONES MATHEMATICAE	1.269	6
INVERSE PROBLEMS	1.248	6
NONLINEARITY	1.159	6
PHYSICA D	1.616	6
AMERICAN JOURNAL OF PHYSICS	0.620	5
ASTROPHYSICS AND SPACE SCIENCE	0.274	5
COMMUNICATIONS IN ALGEBRA	0.320	5
COMPUTER PHYSICS COMMUNICATIONS	1.082	5
INTERNATIONAL JOURNAL OF MATHEMATICS	0.422	5
MATHEMATISCHE ANNALEN	0.691	5
MODERN PHYSICS LETTERS B	0.438	5
ACTA APPLICANDAE MATHEMATICAE	0.469	4
CURRENT SCIENCE	0.600	4
EUROPEAN PHYSICAL JOURNAL A	1.725	4
INTERNATIONAL JOURNAL OF MODERN PHYSICS C	0.728	4
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A	1.026	4
PHYSICA A-STATISTICAL MECHANICS AND ITS APPLICATIONS	1.295	4
PROGRESS IN PARTICLE AND NUCLEAR PHYSICS	2.084	4
ADVANCES IN CHEMICAL PHYSICS	2.828	3
ANNALES DE L INSTITUT HENRI POINCARE-PHYSIQUE THEORIQUE	0.757	3
ANNALS OF THE NEW YORK ACADEMY OF SCIENCES	1.593	3
ASTRONOMY & ASTROPHYSICS	2.281	3
CANADIAN JOURNAL OF MATHEMATICS	0.412	3
DUKE MATHEMATICAL JOURNAL	1.005	3
GEOMETRIC AND FUNCTIONAL ANALYSIS	1.009	3
JOURNAL OF THE AMERICAN MATHEMATICAL SOCIETY	2.133	3
MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY	4.681	3

Citing journal	Impact Factor	Number of times cited
PHILOSOPHICAL TRANS. OF THE ROYAL SOCIETY OF LONDON SERIES A	1.471	3
PHYSICS TODAY	4.790	3
PHYSICS-USPEKHI	NA	3
PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE USA	10.896	3
SPRINGER TRACTS IN MODERN PHYSICS	0.446	3
TOPOLOGY	0.915	3
TRANSACTIONS OF THE AMERICAN MATHEMATICAL SOCIETY	0.600	3
ANNALES DE L INSTITUT FOURIER	0.517	2
AUSTRALIAN JOURNAL OF PHYSICS	0.657	2
BRITISH JOURNAL FOR THE PHILOSOPHY OF SCIENCE	0.722	2
BULLETIN DES SCIENCES MATHEMATIQUES	0.349	2
BULLETIN OF THE AMERICAN MATHEMATICAL SOCIETY	2.650	2
COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE I-MATHEMATIQUE	0.373	2
FEW-BODY SYSTEMS	1.857	2
ISRAEL JOURNAL OF MATHEMATICS	0.545	2
JOURNAL FUR DIE REINE UND ANGEWANDTE MATHEMATIK	0.644	2
JOURNAL OF ALGEBRAIC GEOMETRY	0.776	2
JOURNAL OF ASTROPHYSICS AND ASTRONOMY	0.175	2
JOURNAL OF CHEMICAL PHYSICS	3.147	2
JOURNAL OF OPTICS B-QUANTUM AND SEMICLASSICAL OPTICS	1.415	2
JOURNAL OF PHYSICS-CONDENSED MATTER	1.698	2
MANUSCRIPTA MATHEMATICA	0.386	2
MEMOIRS OF THE AMERICAN MATHEMATICAL SOCIETY	1.393	2
NAGOYA MATHEMATICAL JOURNAL	0.427	2
NATURE	27.955	2
PACIFIC JOURNAL OF MATHEMATICS	0.395	2
PHILOSOPHICAL MAGAZINE B	1.238	2
PHILOSOPHY OF SCIENCE	0.447	2
PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON SERIES A	1.188	2
QUARTERLY JOURNAL OF MATHEMATICS	0.464	2
RIVISTA DEL NUOVO CIMENTO	1.333	2
SCIENCE IN CHINA SERIES A-MATHEMATICS PHYSICS ASTRONOMY	0.340	2
TRANSFORMATION GROUPS	0.781	2
ZEITSCHRIFT FUR NATURFORSCHUNG SECTION A	0.746	2
ZEITSCHRIFT FUR PHYSIK A-HADRONS AND NUCLEI	NA	2
ADVANCES IN NUCLEAR PHYSICS	6.667	1
AMERICAN JOURNAL OF MATHEMATICS	0.883	1
ANNALS OF MATHEMATICS	1.619	1
ANZIAM JOURNAL	0.333	1
ASTRONOMISCHE NACHRICHTEN	0.503	1
ASTROPARTICLE PHYSICS	4.110	1
BIOELECTROCHEMISTRY AND BIOENERGETICS	NA	1
BULLETIN OF THE LONDON MATHEMATICAL SOCIETY	0.409	1
CHAOS	1.935	1
CHEMICAL PHYSICS LETTERS	2.364	1
COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE II	0.366	1
COMPTES RENDUS PHYSIQUE	NA	1
CONTEMPORARY PHYSICS	2.300	1
DISCRETE MATHEMATICS	0.301	1
EUROPEAN JOURNAL OF INORGANIC CHEMISTRY	2.475	1
EUROPEAN PHYSICAL JOURNAL D	1.583	1
FORUM MATHEMATICUM	0.471	1

Citing journal	Impact Factor	Number of times cited
HYPERFINE INTERACTIONS	0.634	1
IAU SYMPOSIA	NA	1
INTERNATIONAL JOURNAL OF BIFURCATION AND CHAOS	0.838	1
INTERNATIONAL MATHEMATICS RESEARCH NOTICES	0.591	1
JOURNAL DE PHYSIQUE I	NA	1
JOURNAL DE PHYSIQUE IV	0.401	1
JOURNAL OF COMPUTATIONAL PHYSICS	1.716	1
JOURNAL OF FUNCTIONAL ANALYSIS	0.879	1
JOURNAL OF LOW TEMPERATURE PHYSICS	0.954	1
JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS	0.444	1
JOURNAL OF NONLINEAR SCIENCE	1.021	1
JOURNAL OF THE OPTICAL SOCIETY OF AMERICA A	1.521	1
LOW TEMPERATURE PHYSICS	0.619	1
MATHEMATICAL MODELS & METHODS IN APPLIED SCIENCES	0.859	1
MATHEMATISCHE ZEITSCHRIFT	0.597	1
MICHIGAN MATHEMATICAL JOURNAL	0.252	1
NONLINEAR ANALYSIS-THEORY METHODS & APPLICATIONS	0.406	1
PHYSICA B	0.663	1
PHYSICA C	0.806	1
PHYSICA E	1.009	1
PHYSICA STATUS SOLIDI B-BASIC RESEARCH	0.873	1
PHYSICS OF PLASMAS	2.223	1
PHYSICS OF THE SOLID STATE	0.623	1
PROCEEDINGS OF THE AMERICAN MATHEMATICAL SOCIETY	0.369	1
SCIENCE	23.329	1
SOLID STATE COMMUNICATIONS	1.381	1
SOVIET JOURNAL OF NUCLEAR PHYSICS-USSR	NA	1
SPECTROCHIMICA ACTA PART A-MOLEC. AND BIOMOLEC. SPECTROSCOPY	0.838	1
STUDIES IN APPLIED MATHEMATICS	0.696	1
TOHOKU MATHEMATICAL JOURNAL	0.348	1
ZHURNAL EKSPERIMENTALNOI I TEORETICHESKOI FIZIKI	NA	1

5.4.5 Highly Citing Authors and Countries

There are 8396 individual authors citing the 'hep-th' e-print archives as per *Science Citation Index* during 1991-2002. Among the top citing authors, Odintsov, S.D. comes first with 99 times cited followed by Lu, H. (88 times), Pope, C.N. (86 times), Cvetic, M. (79 times), Tseytlin, A.A. (77 times), and Ferrara, S. (72 times). Table 17 documents the authors citing the 'hep-th' e-print archives with the corresponding number of times cited. The number of authors citing the 'hep-th' e-print archives is increasing year-by-year. The average percentage growth in number of authors citing e-print archives is 166.46 %. The year-wise growth pattern of authors citing the 'hep-th' e-print archives as per *Science Citation Index* (1991-2002) is presented in Figure 32. Lotka's Law for the publication productivity has been applied to the information use by researchers in the form of citing the 'hep-th' e-print archives. The graphical representation of the same is depicted in Figure 33.

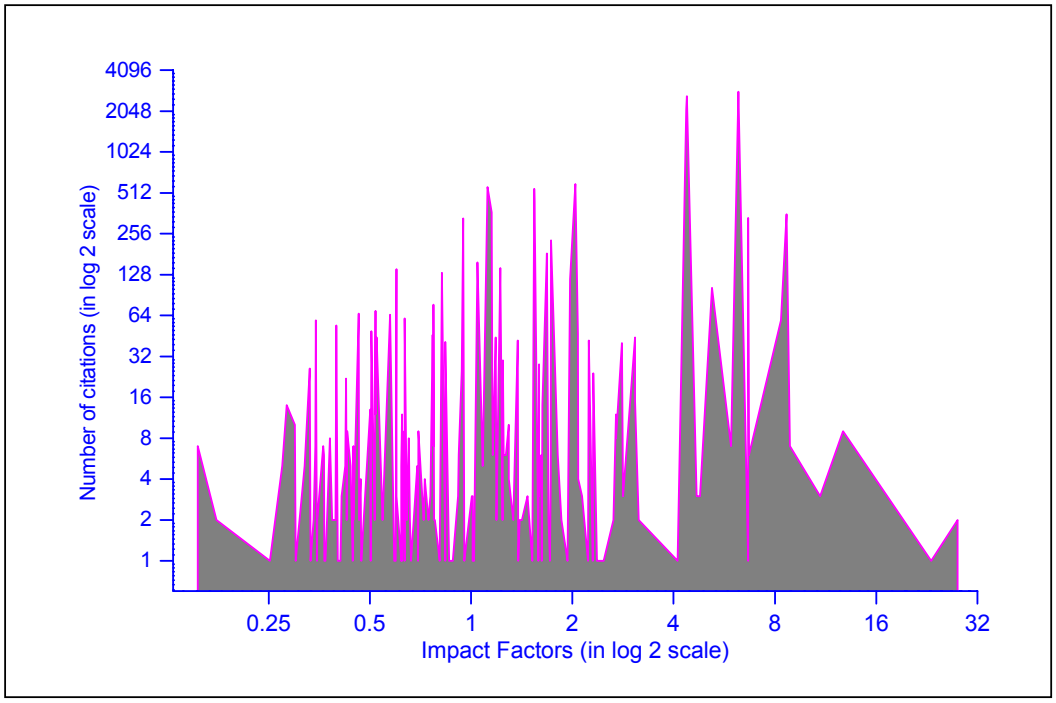

Figure 30: Relationship between the number of times cited and the corresponding Impact Factors of journals citing the 'hep-th' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991 – 2002)

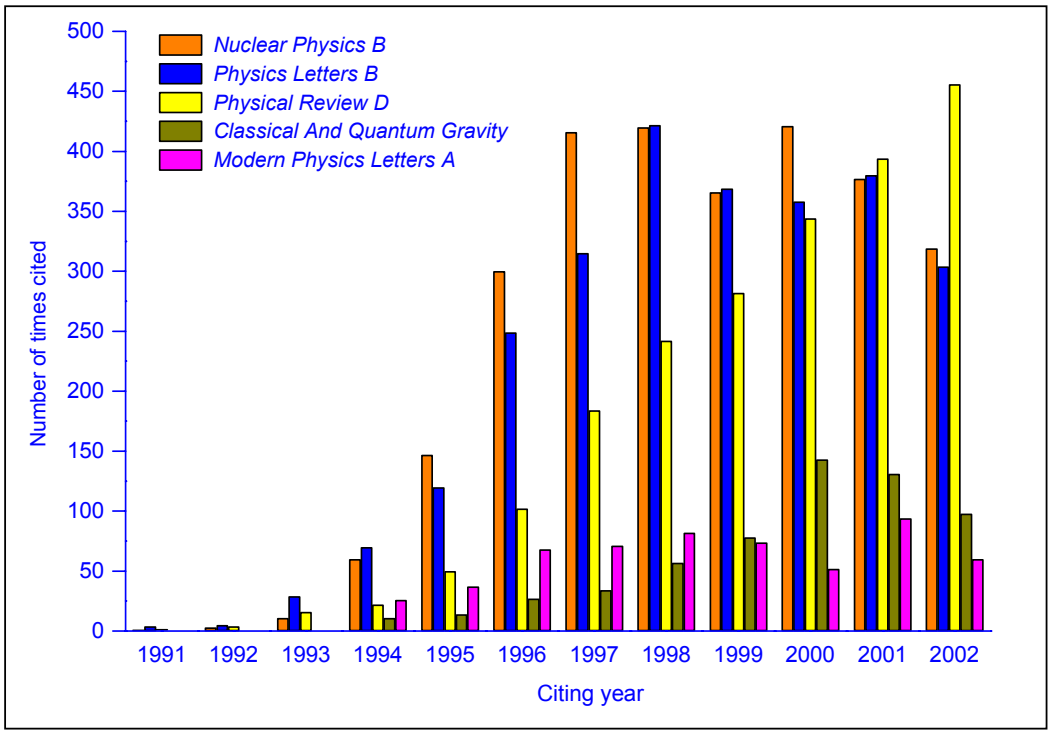

Figure 31: Citing pattern of highly citing five journals of the 'hep-th' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Table 18 is the list of countries in the affiliation of authors citing the 'hep-th' e-print archives. The analysis shows that, among the affiliation of scientists citing the 'hep-th' e-print archives, 24.98 % are from USA followed by Italy (9.20 %), Japan (6.78 %), Germany (6.55 %), and England (6.32 %).

Table 17: Authors citing the 'hep-th' archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Citing author	No. of times cited	Citing author	No. of times cited	Citing author	No. of times cited
Odintsov-SD	99	Johnson-CV	32	Schwarz-JH	25
Lu-H	88	Mathur-SD	32	Semenoff-GW	25
Pope-CN	86	Dauria-R	31	Strominger-A	25
Cvetic-M	79	Ellis-J	31	Andrianopoli-L	24
Tseytlin-AA	77	Faraggi-AE	31	Buchbinder-IL	24
Ferrara-S	72	Moore-G	31	Chu-CS	24
Nojiri-S	69	Kleinert-H	30	Gorsky-A	24
Klebanov-IR	58	Amelinocamelia-G	29	Intriligator-K	24
Lust-D	54	Bytsenko-AA	29	Kaloper-N	24
Vafa-C	54	Oz-Y	29	Ketov-SV	24
Gibbons-GW	48	Sezgin-E	29	Kiritsis-E	24
Mavromatos-NE	48	Sheikhjabbari-MM	29	Kounnas-C	24
Antoniadis-I	47	Shifman-M	29	Mohaupt-T	24
Kakushadze-Z	47	Sonnenschein-J	29	Morozov-A	24
Kogan-II	47	Cardoso-GL	28	Park-DK	24
Bergshoeff-E	46	Li-M	28	Theisen-S	24
Kallosh-R	44	Porrati-M	28	Tye-SHH	24
Hou-BY	42	Das-A	27	Adam-C	23
Youm-D	40	Hull-CM	27	Berkovits-N	23
Townsend-PK	39	Kachru-S	27	Dhoker-E	23
Witten-E	39	Lee-K	27	Gaberdiel-MR	23
Damgaard-PH	38	Schaposnik-FA	27	Itoyama-H	23
Henneaux-M	38	Sorokin-D	27	Liu-JT	23
Ooguri-H	38	Szabo-RJ	27	Nishino-H	23
Ahn-C	37	West-PC	27	Ohta-N	23
Behrndt-K	37	Zaffaroni-A	27	Skiba-W	23
Papadopoulos-G	37	Bak-D	26	Sokatchev-E	23
Rey-SJ	37	Das-SR	26	Stelle-KS	23
Duff-MJ	36	Dewit-B	26	Zarembo-K	23
Dvali-G	36	Dudas-E	26	Zwiebach-B	23
Myers-RC	36	Emparan-R	26	Blumenhagen-R	22
Sen-A	36	Giveon-A	26	Bonora-L	22
Myung-YS	34	Larsen-F	26	Figueroaofarrill-JM	22
Bars-I	33	Lidsey-JE	26	Fuchs-J	22
Fre-P	33	Ambjorn-J	25	Gomis-J	22
Nanopoulos-DV	33	Arefeva-IY	25	Ivanov-E	22
Sabra-WA	33	Castro-C	25	Kiem-Y	22
Seiberg-N	33	Gubser-SS	25	Lambert-ND	22
Csaki-C	32	Ho-PM	25	Lee-HW	22
Elizalde-E	32	Leigh-RG	25	Maharana-J	22
Horowitz-GT	32	Lowe-DA	25	Marshakov-A	22
Howe-PS	32	Lukierski-J	25	Mironov-A	22

Citing author	No. of times cited
Mullerkirsten-HJW	22
Oda-I	22
Park-J	22
Polchinski-J	22
Russo-JG	22
Sagnotti-A	22
Shiu-G	22
Silverstein-E	22
Taylor-TR	22
Wadia-SR	22
Zanon-D	22
Chamblin-A	21
Gabadadze-G	21
Ganor-OJ	21
Gukov-S	21
Hollowood-TJ	21
Khoze-VV	21
Kumar-A	21
Lozano-Y	21
Marino-M	21
Matone-M	21
Obregon-O	21
Polychronakos-AP	21
Rabinovici-E	21
Sato-HT	21
Schweigert-C	21
Taylor-W	21
Visser-M	21
Yanagida-T	21
Yang-SK	21
Yankielowicz-S	21
Banados-M	20
Banks-T	20
Cai-RG	20
Hanany-A	20
Ibanez-LE	20
Karch-A	20
Khuri-RR	20
Louis-J	20
Mann-RB	20
Minic-D	20
Verbaarschot-JJM	20
Yi-PJ	20
Aharony-O	19
Arkanihamed-N	19
Barbon-JLF	19
Brax-P	19
Cadoni-M	19
Deser-S	19
Dienes-KR	19
Freedman-DZ	19
Green-MB	19
Ito-K	19
Kawai-H	19

Citing author	No. of times cited
Kirsten-K	19
Leontaris-GK	19
Linde-A	19
Nekrasov-N	19
Nunez-C	19
Ortin-T	19
Park-YJ	19
Rovelli-C	19
Saleur-H	19
Sfetsos-K	19
Uranga-AM	19
Alishahiha-M	18
Anselmi-D	18
Balachandran-AP	18
Balasubramanian-V	18
Berkooz-M	18
Binetruy-P	18
Chaichian-M	18
Curio-G	18
Deboer-J	18
Dine-M	18
Douglas-MR	18
Fujikawa-K	18
Greene-BR	18
Janik-RA	18
Kim-WT	18
Kitazawa-Y	18
Kutasov-D	18
Li-TJ	18
Mandal-G	18
Matsuo-Y	18
Navarrosalas-J	18
Nicolai-H	18
Rajaraman-A	18
Ramgoolam-S	18
Restuccia-A	18
Reuter-M	18
Schnitzer-HJ	18
Scrucca-CA	18
Sundell-P	18
Terning-J	18
Vanproeyen-A	18
Veneziano-G	18
Viswanathan-KS	18
Wands-D	18
Warner-NP	18
Yoneya-T	18
Banerjee-R	17
Bertolini-M	17
Bianchi-M	17
Brandt-F	17
Chamseddine-AH	17
Dasgupta-K	17
Gauntlett-JP	17

Citing author	No. of times cited
Geyer-B	17
Gomez-C	17
Hori-K	17
Klemm-D	17
Krivonos-S	17
Lalak-Z	17
Lizzi-F	17
Maeda-K	17
Maldacena-JM	17
Marolf-D	17
Minasian-R	17
Nilles-HP	17
Okuyama-K	17
Pawlowski-JM	17
Pioline-B	17
Polikarpov-MI	17
Quiros-M	17
Schmaltz-M	17
Schroer-B	17
Skenderis-K	17
Smolin-L	17
Spallucci-E	17
Tonin-M	17
Wetterich-C	17
Yang-WL	17
Zerbini-S	17
Authors citing 16 times	
Authors citing 15 times	
Authors citing 14 times	
Authors citing 13 times	
Authors citing 12 times	
Authors citing 11 times	
Authors citing ten times	
Authors citing nine times	
Authors citing eight times	
Authors citing seven times	
Authors citing six times	
Authors citing five times	
Authors citing four times	
Authors citing three times	
Authors citing two times	
Authors citing only once	

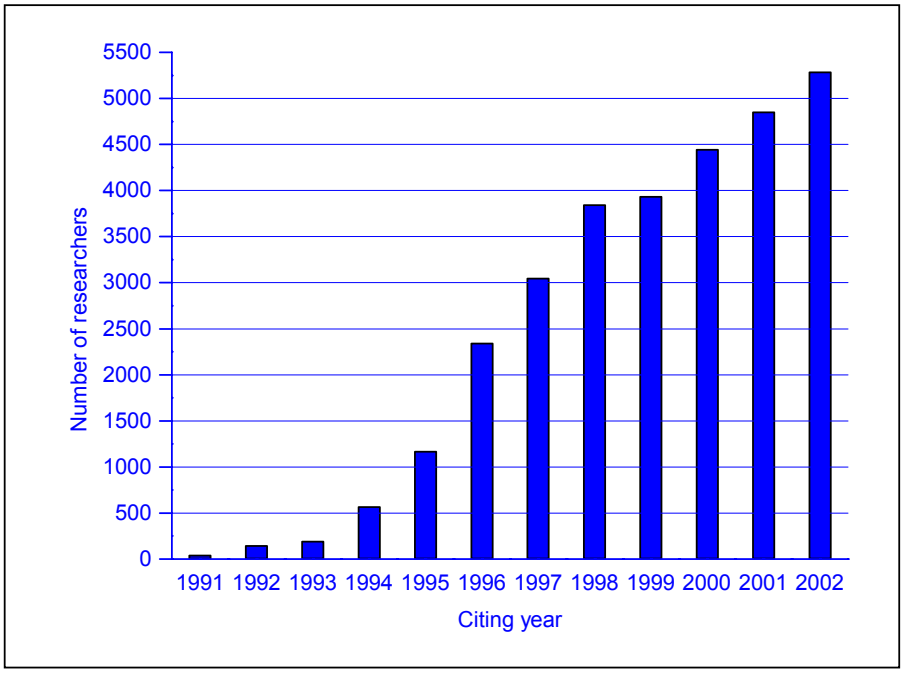

Figure 32: Number of researchers citing the 'hep-th' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

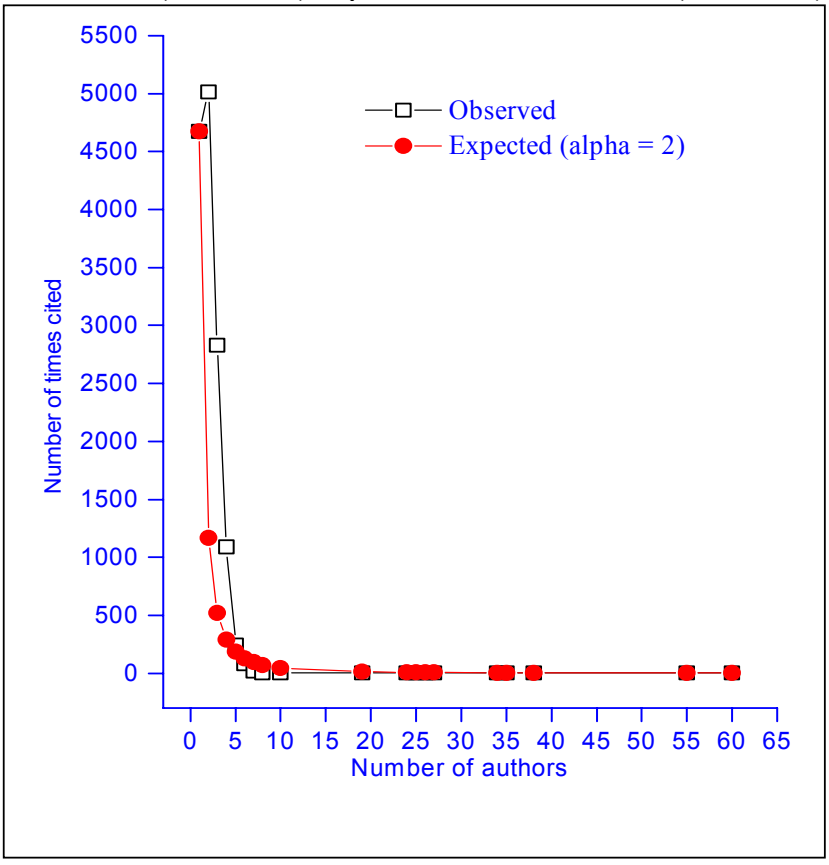

Figure 33: Lotka's Law applied to information use by authors citing the 'hep-th' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Table 18: Countries in the affiliation of the citing authors of the 'hep-th' e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Citing Country	Number of times cited	%
USA	6566	24.98
ITALY	2417	9.20
JAPAN	1782	6.78
GERMANY	1721	6.55
ENGLAND	1662	6.32
RUSSIA	1476	5.62
FRANCE	1291	4.91
SWITZERLAND	954	3.63
SPAIN	776	2.95
SOUTH-KOREA	754	2.87
INDIA	576	2.19
BRAZIL	573	2.18
PEOPLES-R-CHINA	572	2.18
CANADA	545	2.07
NETHERLANDS	384	1.46
ISRAEL	291	1.11
POLAND	281	1.07
BELGIUM	265	1.01
IRAN	254	0.97
SWEDEN	243	0.92
GREECE	225	0.86
MEXICO	223	0.85
DENMARK	209	0.80
ARGENTINA	166	0.63
AUSTRALIA	157	0.60
AUSTRIA	149	0.57
TAIWAN	141	0.54
FINLAND	136	0.52
UKRAINE	129	0.49
CHILE	126	0.48
IRELAND	116	0.44
PORTUGAL	94	0.36
HUNGARY	84	0.32
WALES	69	0.26
TURKEY	66	0.25
ARMENIA	63	0.24
BULGARIA	60	0.23
SCOTLAND	57	0.22
VENEZUELA	55	0.21
NORWAY	52	0.20
ROMANIA	51	0.19
CZECH-REPUBLIC	46	0.18
MOROCCO	46	0.18
REP-OF-GEORGIA	40	0.15
LEBANON	38	0.14
SOUTH-AFRICA	36	0.14
CROATIA	29	0.11
SLOVENIA	28	0.11
SINGAPORE	25	0.10
COLOMBIA	24	0.09
SLOVAKIA	19	0.07
YUGOSLAVIA	15	0.06
ESTONIA	14	0.05
URUGUAY	11	0.04
COSTA-RICA	10	0.04
EGYPT	10	0.04
ALGERIA	8	0.03
BYELARUS	8	0.03
CYPRUS	8	0.03
KYRGYZSTAN	6	0.02
MOLDOVA	6	0.02
VIETNAM	5	0.02
ICELAND	4	0.02
NEW-ZEALAND	4	0.02
AZERBAIJAN	3	0.01
FED-REP-GER	3	0.01
HONG-KONG	3	0.01
PAKISTAN	3	0.01
SRI-LANKA	3	0.01
UZBEKISTAN	3	0.01
BENIN	2	0.01
KAZAKHSTAN	2	0.01
BANGLADESH	1	0.00
CZECHOSLOVAKIA	1	0.00
ECUADOR	1	0.00
GUADELOUPE	1	0.00
JORDAN	1	0.00
NEPAL	1	0.00
SAUDI-ARABIA	1	0.00
USSR	1	0.00
VATICAN	1	0.00
Total	**26282**	**100.00**

5.5 Inter-Comparison of High Energy Physics E-print Archives

The study refers LANL high-energy physics e-print archives as all the e-print archives submitted to the four categories of high-energy physics, viz. high energy physics - experiment (hep-ex), high energy physics - lattice (hep-lat), high energy physics - phenomenology (hep-ph), and high energy physics - theory (hep-th). The scope of these high-energy physics e-print archives includes: high energy experimental physics, lattice field theory, lattice QCD (numerical and analytical), particle spectrum, finite temperature QCD, weak interaction physics, QED, algorithms, spin systems, random surfaces/quantum gravity, special purpose computers, comparison with experiments and other analytical developments, particle phenomenology, string/conformal/field theory etc.

The submission dates of high-energy physics e-print archives studied spans from August 14, 1991 to 2002. The 'hep-ph' category stands first in number of submissions with 47.69 % of the total, even though the 'hep-th' started before 'hep-ph' category, followed by the 'hep-th' category with 39.24 %, 'hep-lat' with 7.49 %, and 'hep-ex' with 5.58 %. Table 19 presents the submission pattern of the four categories of high-energy physics e-print archives.

The citation pattern of the high-energy physics e-print archives are presented in Table 20. The number of e-print archives, which have got at least one citation from each category is given with percentage of total submissions. The 'hep-th' category e-prints are being highly cited (46.81 %) by researchers, followed by the 'hep-ph' category with 39.32 %, the 'hep-lat' category with 38.23 %, and the 'hep-ex' category with 31.29 %. The citing pattern of the top cited e-print archives from each category before and after publication in a formal source(s) as per *Science Citation Index* (1991-2002) are presented in Figure 34.

Table 19: Break-up of number of submission of LANL high-energy physics (HEP) e-print archives till 2002

E-Print Archive Category	Started in	No. of submissions	% of Total
hep-ex	April 15, 1994	4142	5.58
hep-lat	December 1, 1991	5564	7.49
hep-ph	March 7, 1992	35420	47.69
hep-th	August 14, 1991	29140	39.24
HEP	**August 14, 1991**	**74266**	**100.00**

The citations received to each e-print archives as per *Science Citation Index* (1991-2002) are treated as the income to that. The comparison of this phenomenon for the four categories is depicted through Lorenz Curves in Figure 35. The 'hep-ph' category has high Gini's Coefficient of 0.70 followed by 'hep-th' category (0.68), 'hep-ex' category (0.62) and 'hep-lat' category (0.61). The over all Gini's Coefficient for the high-energy physics e-print archives is 0.65.

Table 20: Distribution of citation received at least once for LANL high-energy physics (HEP) e-print archives as per *Science Citation Index* (1991-2002)

E-Print Archive Category	No. of submissions	Citations received	% of Total submissions
hep-ex	4142	1296	31.29
hep-lat	5564	2127	38.23
hep-ph	35420	13928	39.32
hep-th	29140	13639	46.81
HEP	**74266**	**30990**	**41.73**

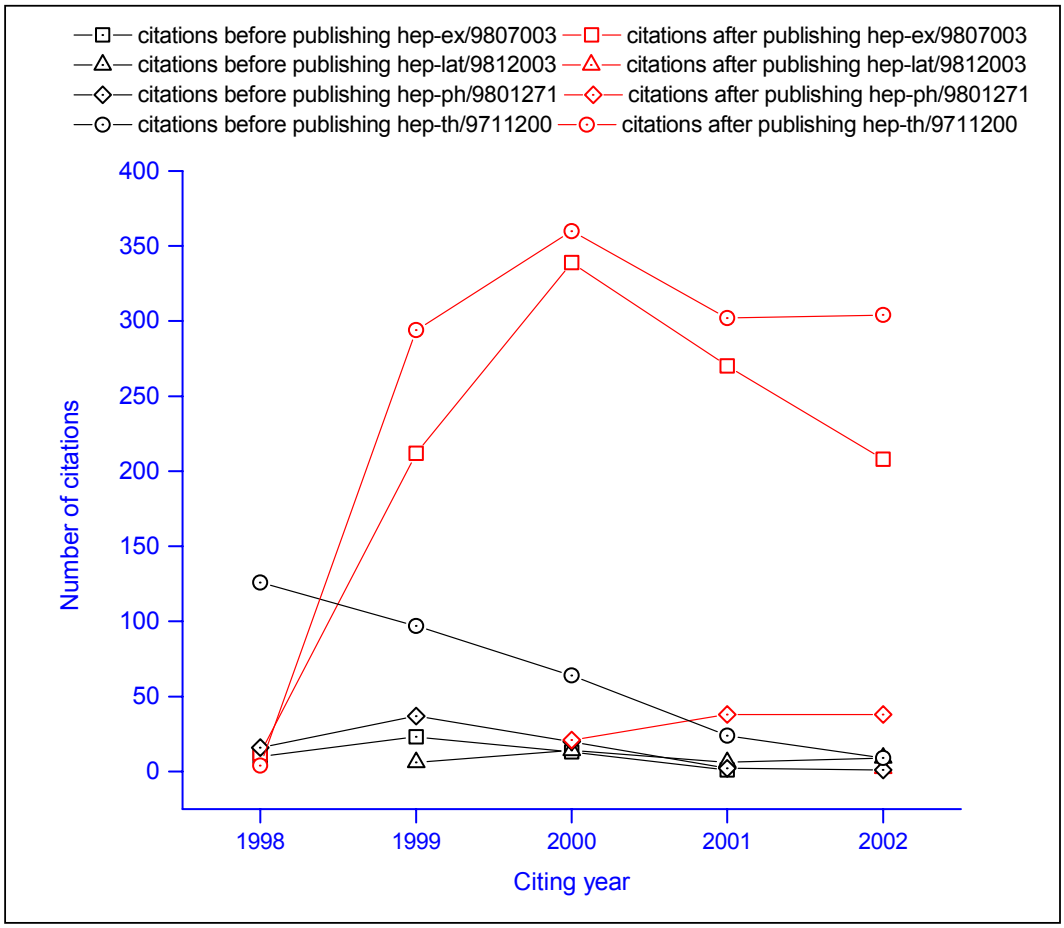

Figure 34: The citing pattern of top cited, among the four categories of high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002) before and after publishing in a formal source

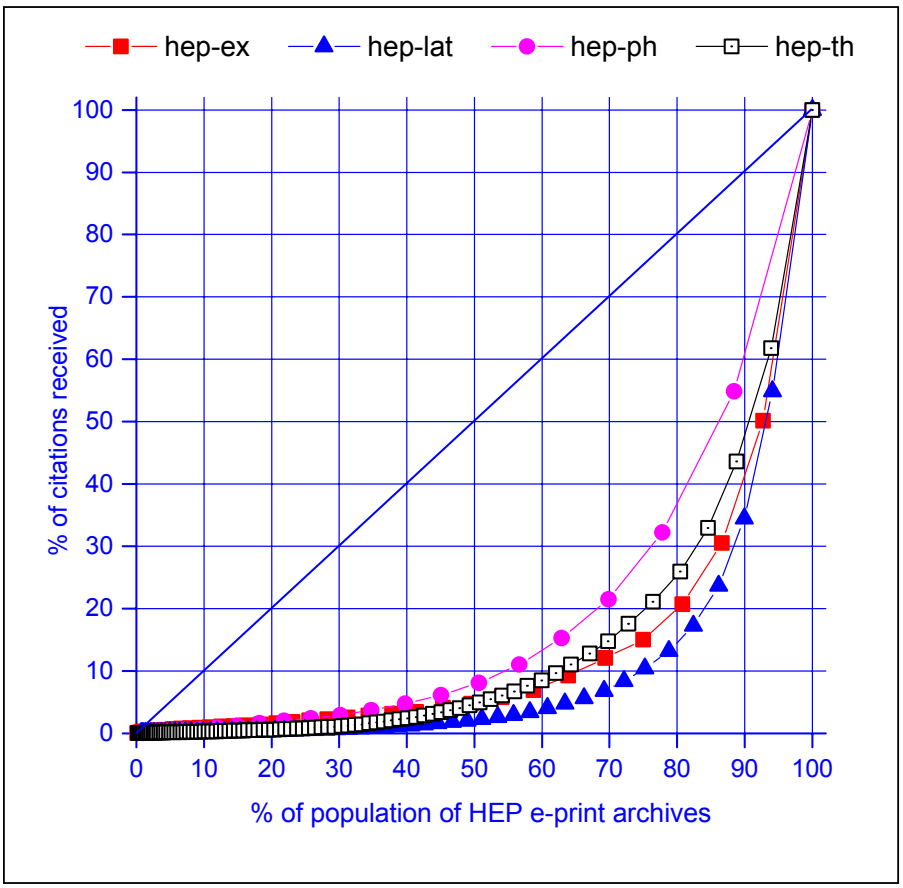

Figure 35: Lorenz Curves for the four categories of LANL high-energy physics e-print archives (1994-2002) based on citations received as per *Science Citation Index* (1991-2002)

Table 21 documented the journals citing high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002). Among the highly citing journals, *Physics Letters B* cited maximum number of times (19.55 %) followed by *Physical Review D* (19.45 %), *Nuclear Physics B* (14.10 %), *Nuclear Physics B - Proceedings Supplements* (6.58 %), and *Physical Review Letters* (3.57 %). Figue 36 shows the correlation between the number of times cited by the journals citing high-energy physics e-print archives and the corresponding Impact Factors.

Table 22 lists the prominent authors citing high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002). Among them Ellis, J. comes first with 153 times cited followed by Banerjee, S. (113 times), Odintsov, S.D. (109 times), Mohapatra, R.N. (102 times), and Schafer, A. (96 times). Lotka's Law has been applied to the information use by the authors of high-energy physics e-print archives. Figure 37 depicts the

Law applied for the authors citing and for the number of times cited instead of number of publications in the original Law.

Table 23 lists the countries in the affiliation of the authors citing high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002). The USA is occurring 22985 times in the affiliations of citing authors followed by Italy (9515 times), Germany (7617 times), Japan (5667 times), and England (4315 times).

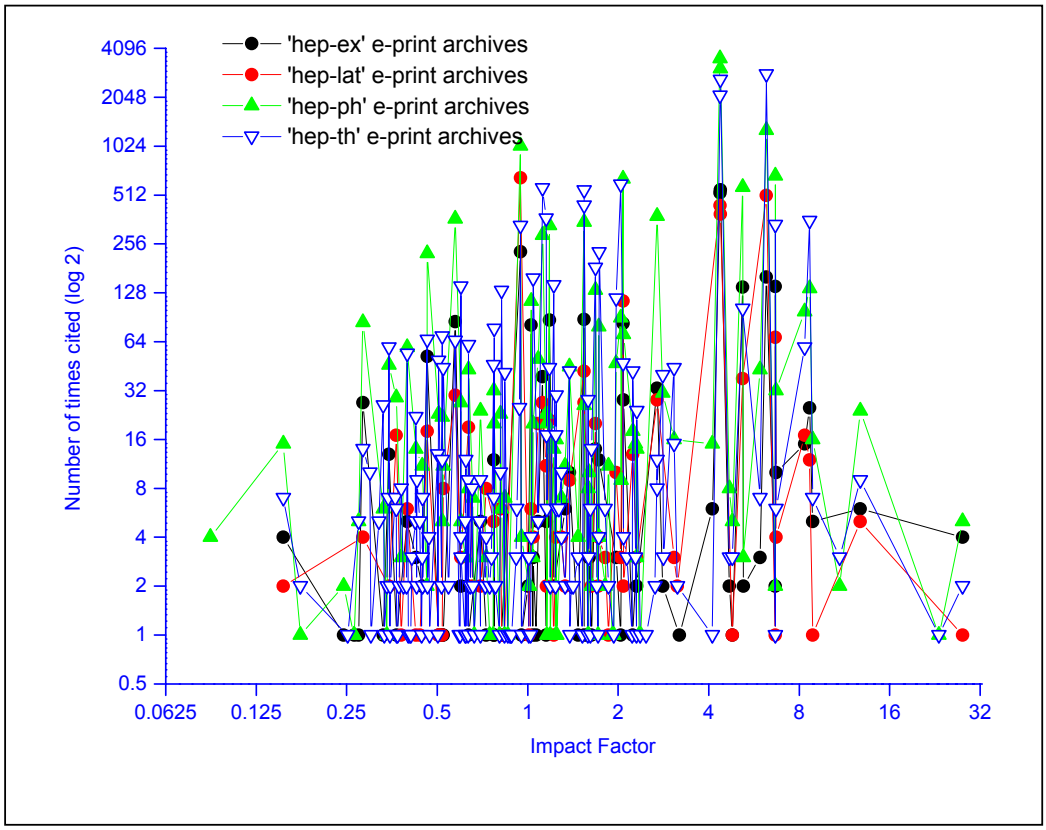

Figure 36: Relationship between the number of times cited and the corresponding Impact Factors of journals citing the high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991 – 2002) in log-log graph

Table 21: Journals citing high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Citing journals	hep-ex	hep-lat	hep-ph	hep-th	Total	%
PHYSICS LETTERS B	550	391	3078	2625	6644	19.55
PHYSICAL REVIEW D	527	442	3544	2098	6611	19.45
NUCLEAR PHYSICS B	160	509	1283	2841	4793	14.10
NUCLEAR PHYSICS B-PROCEEDINGS SUPPLEMENTS	229	652	1026	331	2238	6.58
PHYSICAL REVIEW LETTERS	140	68	672	335	1215	3.57
INTERNATIONAL JOURNAL OF MODERN PHYSICS A	88	42	349	549	1028	3.02
MODERN PHYSICS LETTERS A	39	27	290	564	920	2.71
NUCLEAR PHYSICS A	83	114	644	47	888	2.61
EUROPEAN PHYSICAL JOURNAL C	139	38	571	102	850	2.50
CLASSICAL AND QUANTUM GRAVITY	1	3	90	593	687	2.02
ACTA PHYSICA POLONICA B	85	30	365	65	545	1.60
JOURNAL OF HIGH ENERGY PHYSICS	25	12	136	355	528	1.55
JOURNAL OF PHYSICS A	1	27	26	441	495	1.46
PHYSICAL REVIEW C	33	28	380	20	461	1.36
JOURNAL OF PHYSICS G	87	21	333	0	441	1.30
JOURNAL OF MATHEMATICAL PHYSICS	1	11	23	367	402	1.18
PHYSICS OF ATOMIC NUCLEI	52	18	224	66	360	1.06
PROGRESS OF THEORETICAL PHYSICS	14	20	133	183	350	1.03
COMMUNICATIONS IN MATHEMATICAL PHYSICS	0	0	4	228	232	0.68
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS A	81	6	114	4	205	0.60
PHYSICS REPORTS-REVIEW SECTION OF PHYSICS LETTERS	15	17	98	59	189	0.56
FORTSCHRITTE DER PHYSIK-PROGRESS OF PHYSICS	3	4	20	157	184	0.54
ANNALS OF PHYSICS	3	10	47	118	178	0.52
THEORETICAL AND MATHEMATICAL PHYSICS	2	3	27	140	172	0.51
PHYSICS LETTERS A	2	1	14	143	160	0.47
LETTERS IN MATHEMATICAL PHYSICS	1	1	6	132	140	0.41
PRAMANA-JOURNAL OF PHYSICS	27	4	84	14	129	0.38
COMMUNICATIONS IN THEORETICAL PHYSICS	5	6	59	54	124	0.36
PROGRESS OF THEORETICAL PHYSICS SUPPLEMENT	1	19	43	61	124	0.36
CZECHOSLOVAK JOURNAL OF PHYSICS	13	2	46	59	120	0.35
JETP LETTERS	10	9	45	42	106	0.31
PROGRESS IN PARTICLE AND NUCLEAR PHYSICS	28	2	71	4	105	0.31
ZEITSCHRIFT FUR PHYSIK C-PARTICLES AND FIELDS	0	3	66	32	101	0.30
EUROPEAN PHYSICAL JOURNAL A	12	4	79	4	99	0.29
GENERAL RELATIVITY AND GRAVITATION	1	0	20	77	98	0.29
INTERNATIONAL JOURNAL OF THEORETICAL PHYSICS	1	0	22	69	92	0.27
COMPUTER PHYSICS COMMUNICATIONS	5	20	50	5	80	0.24
PHYSICAL REVIEW B	0	3	16	59	78	0.23
JOURNAL OF THE KOREAN PHYSICAL SOCIETY	1	1	23	49	74	0.22
PHYSICAL REVIEW E	1	13	18	42	74	0.22
PHYSICAL REVIEW A	2	0	31	40	73	0.21
INTERNATIONAL JOURNAL OF MODERN PHYSICS B	1	8	11	44	64	0.19
PHYSICA SCRIPTA	12	5	32	7	56	0.16
ASTROPHYSICAL JOURNAL	3	0	43	7	53	0.16
ANNUAL REVIEW OF NUCLEAR AND PARTICLE SCIENCE	10	4	32	6	52	0.15
CHINESE JOURNAL OF PHYSICS	0	17	29	6	52	0.15
CHAOS SOLITONS & FRACTALS	0	0	7	41	48	0.14
INTERNATIONAL JOURNAL OF MODERN PHYSICS D	0	0	16	30	46	0.14
JOURNAL OF GEOMETRY AND PHYSICS	0	0	0	46	46	0.14
JOURNAL OF EXPERIMENTAL AND THEORETICAL PHYSICS	5	2	20	17	44	0.13
JOURNAL OF PHYSICS G-NUCLEAR AND PARTICLE PHYSICS	0	0	0	44	44	0.13
REVIEWS OF MODERN PHYSICS	6	5	24	9	44	0.13
EUROPHYSICS LETTERS	2	3	14	24	43	0.13
FOUNDATIONS OF PHYSICS	3	1	14	22	40	0.12

Citing journals	hep-ex	hep-lat	hep-ph	hep-th	Total	%
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA A	5	2	24	9	40	0.12
CHINESE PHYSICS LETTERS	0	6	23	10	39	0.11
ANNALEN DER PHYSIK	1	0	8	28	37	0.11
NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA B	1	0	6	26	33	0.10
REPORTS ON PROGRESS IN PHYSICS	5	1	16	7	29	0.09
REVISTA MEXICANA DE FISICA	4	2	15	7	28	0.08
PHYSICA A	0	4	7	14	25	0.07
REVIEWS IN MATHEMATICAL PHYSICS	0	0	0	25	25	0.07
USPEKHI FIZICHESKIKH NAUK	2	4	11	8	25	0.07
ZEITSCHRIFT FUR PHYSIK A	1	0	20	2	23	0.07
ASTROPARTICLE PHYSICS	6	0	15	1	22	0.06
JOURNAL OF STATISTICAL PHYSICS	0	4	1	17	22	0.06
RIVISTA DEL NUOVO CIMENTO	6	2	11	2	21	0.06
HELVETICA PHYSICA ACTA	1	1	5	12	19	0.06
JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN	1	2	2	14	19	0.06
ASTRONOMY & ASTROPHYSICS	0	0	15	3	18	0.05
INTERNATIONAL JOURNAL OF MODERN PHYSICS C	1	8	3	4	16	0.05
SPRINGER TRACTS IN MODERN PHYSICS	2	0	11	3	16	0.05
CANADIAN JOURNAL OF PHYSICS	0	0	3	12	15	0.04
FEW-BODY SYSTEMS	0	1	11	2	14	0.04
JOURNAL OF ALGEBRA	0	0	0	13	13	0.04
MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY	2	0	8	3	13	0.04
SPACE SCIENCE REVIEWS	3	0	10	0	13	0.04
FOUNDATIONS OF PHYSICS LETTERS	0	1	3	8	12	0.04
NATURE	4	1	5	2	12	0.04
ASTROPHYSICS AND SPACE SCIENCE	1	0	5	5	11	0.03
AUSTRALIAN JOURNAL OF PHYSICS	0	2	7	2	11	0.03
EUROPEAN PHYSICAL JOURNAL B	0	3	2	6	11	0.03
HYPERFINE INTERACTIONS	2	0	8	1	11	0.03
JOURNAL OF DIFFERENTIAL GEOMETRY	0	0	0	10	10	0.03
PHYSICS TODAY	1	1	5	3	10	0.03
PHYSICS-USPEKHI	1	0	6	3	10	0.03
CURRENT SCIENCE	0	0	5	4	9	0.03
JOURNAL OF PHYSICS B	0	0	9	0	9	0.03
JOURNAL OF PURE AND APPLIED ALGEBRA	0	0	0	9	9	0.03
MATHEMATICAL RESEARCH LETTERS	0	0	0	9	9	0.03
ADVANCES IN MATHEMATICS	0	0	0	8	8	0.02
AMERICAN JOURNAL OF PHYSICS	0	0	3	5	8	0.02
PHILOS. TRANS. OF THE ROYAL SOC. OF LONDON SERIES A	1	0	4	3	8	0.02
COMPOSITIO MATHEMATICA	0	0	0	7	7	0.02
CONTEMPORARY PHYSICS	3	0	3	1	7	0.02
JOURNAL OF KNOT THEORY AND ITS RAMIFICATIONS	0	0	0	7	7	0.02
NONLINEARITY	0	0	1	6	7	0.02
RUSSIAN MATHEMATICAL SURVEYS	0	0	0	7	7	0.02
ADVANCES IN NUCLEAR PHYSICS	2	1	2	1	6	0.02
ANNALES HENRI POINCARE	0	0	0	6	6	0.02
INVENTIONES MATHEMATICAE	0	0	0	6	6	0.02
INVERSE PROBLEMS	0	0	0	6	6	0.02
JOURNAL OF LOW TEMPERATURE PHYSICS	1	0	4	1	6	0.02
MODERN PHYSICS LETTERS B	0	1	0	5	6	0.02
PHYSICA D	0	0	0	6	6	0.02
ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES	2	0	3	0	5	0.01
COMMUNICATIONS IN ALGEBRA	0	0	0	5	5	0.01
INTERNATIONAL JOURNAL OF MATHEMATICS	0	0	0	5	5	0.01
MATHEMATISCHE ANNALEN	0	0	0	5	5	0.01
PROC. OF THE NAT. ACADEMY OF SCIENCES OF THE U.S.A.	0	0	2	3	5	0.01
ACTA APPLICANDAE MATHEMATICAE	0	0	0	4	4	0.01
ANNALS OF THE NEW YORK ACADEMY OF SCIENCES	0	0	1	3	4	0.01
IZVESTIYA AKADEMII NAUK SERIYA FIZICHESKAYA	0	0	4	0	4	0.01

Citing journals	hep-ex	hep-lat	hep-ph	hep-th	Total	%
JOURNAL OF CHEMICAL PHYSICS	0	2	0	2	4	0.01
JOURNAL OF COMPUTATIONAL PHYSICS	0	2	1	1	4	0.01
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS B	1	0	3	0	4	0.01
PHYSICA E	0	1	2	1	4	0.01
ADVANCES IN CHEMICAL PHYSICS	0	0	0	3	3	0.01
ANNALES DE L INSTITUT HENRI POINCARE-PHYSIQUE THEORIQUE	0	0	0	3	3	0.01
CANADIAN JOURNAL OF MATHEMATICS	0	0	0	3	3	0.01
COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE IV	1	0	2	0	3	0.01
DUKE MATHEMATICAL JOURNAL	0	0	0	3	3	0.01
EUROPEAN PHYSICAL JOURNAL D	1	0	1	1	3	0.01
FUSION SCIENCE AND TECHNOLOGY	2	0	1	0	3	0.01
GEOMETRIC AND FUNCTIONAL ANALYSIS	0	0	0	3	3	0.01
JOURNAL OF ASTROPHYSICS AND ASTRONOMY	0	0	1	2	3	0.01
JOURNAL OF THE AMERICAN MATHEMATICAL SOCIETY	0	0	0	3	3	0.01
PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON SERIES A	0	0	1	2	3	0.01
SPECTROCHIMICA ACTA PART A	0	1	1	1	3	0.01
TOPOLOGY	0	0	0	3	3	0.01
TRANSACTIONS OF THE AMERICAN MATHEMATICAL SOCIETY	0	0	0	3	3	0.01
ZEITSCHRIFT FUR NATURFORSCHUNG SECTION A	0	0	1	2	3	0.01
ADVANCES IN SPACE RESEARCH	0	0	2	0	2	0.01
ANNALES DE L INSTITUT FOURIER	0	0	0	2	2	0.01
ASTRONOMY LETTERS-A	0	0	2	0	2	0.01
BRITISH JOURNAL FOR THE PHILOSOPHY OF SCIENCE	0	0	0	2	2	0.01
BULLETIN DES SCIENCES MATHEMATIQUES	0	0	0	2	2	0.01
BULLETIN OF THE AMERICAN MATHEMATICAL SOCIETY	0	0	0	2	2	0.01
CHAOS	0	0	1	1	2	0.01
COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE II	1	0	0	1	2	0.01
COMPTES RENDUS DE L ACADEMIE DES SCIENCES SERIE I	0	0	0	2	2	0.01
IAU SYMPOSIA	0	0	1	1	2	0.01
INSTRUMENTS AND EXPERIMENTAL TECHNIQUES	1	0	1	0	2	0.01
ISRAEL JOURNAL OF MATHEMATICS	0	0	0	2	2	0.01
JOURNAL FUR DIE REINE UND ANGEWANDTE MATHEMATIK	0	0	0	2	2	0.01
JOURNAL OF ALGEBRAIC GEOMETRY	0	0	0	2	2	0.01
JOURNAL OF OPTICS B-QUANTUM AND SEMICLASSICAL OPTICS	0	0	0	2	2	0.01
JOURNAL OF PHYSICS-CONDENSED MATTER	0	0	0	2	2	0.01
MANUSCRIPTA MATHEMATICA	0	0	0	2	2	0.01
MEMOIRS OF THE AMERICAN MATHEMATICAL SOCIETY	0	0	0	2	2	0.01
NAGOYA MATHEMATICAL JOURNAL	0	0	0	2	2	0.01
PACIFIC JOURNAL OF MATHEMATICS	0	0	0	2	2	0.01
PHILOSOPHICAL MAGAZINE B	0	0	0	2	2	0.01
PHILOSOPHY OF SCIENCE	0	0	0	2	2	0.01
PHYSICA B	0	0	1	1	2	0.01
PHYSICA C	0	0	1	1	2	0.01
QUARTERLY JOURNAL OF MATHEMATICS	0	0	0	2	2	0.01
RADIATION MEASUREMENTS	2	0	0	0	2	0.01
SCIENCE	0	0	1	1	2	0.01
SCIENCE IN CHINA SERIES A	0	0	0	2	2	0.01
TRANSFORMATION GROUPS	0	0	0	2	2	0.01
ACTA ASTRONOMICA	0	0	1	0	1	0.00
AMERICAN JOURNAL OF MATHEMATICS	0	0	0	1	1	0.00
ANNALS OF MATHEMATICS	0	0	0	1	1	0.00
ANZIAM JOURNAL	0	0	0	1	1	0.00
APPLIED SURFACE SCIENCE	1	0	0	0	1	0.00
ASTRONOMISCHE NACHRICHTEN	0	0	0	1	1	0.00
ASTRONOMY & ASTROPHYSICS SUPPLEMENT SERIES	0	0	1	0	1	0.00
ATOMIC DATA AND NUCLEAR DATA TABLES	1	0	0	0	1	0.00
BIOELECTROCHEMISTRY AND BIOENERGETICS	0	0	0	1	1	0.00
BULLETIN OF THE LONDON MATHEMATICAL SOCIETY	0	0	0	1	1	0.00
CHEMICAL PHYSICS LETTERS	0	0	0	1	1	0.00

Citing journals	hep-ex	hep-lat	hep-ph	hep-th	Total	%
COMPTES RENDUS PHYSIQUE	0	0	0	1	1	0.00
DISCRETE MATHEMATICS	0	0	0	1	1	0.00
DOKLADY PHYSICS	1	0	0	0	1	0.00
EUROPEAN JOURNAL OF INORGANIC CHEMISTRY	0	0	0	1	1	0.00
FORUM MATHEMATICUM	0	0	0	1	1	0.00
IEEE TRANSACTIONS ON NUCLEAR SCIENCE	1	0	0	0	1	0.00
INFORMATION SCIENCES	0	0	1	0	1	0.00
INTERNATIONAL JOURNAL OF BIFURCATION AND CHAOS	0	0	0	1	1	0.00
INTERNATIONAL JOURNAL OF QUANTUM CHEMISTRY	0	0	1	0	1	0.00
INTERNATIONAL MATHEMATICS RESEARCH NOTICES	0	0	0	1	1	0.00
JOURNAL DE PHYSIQUE I	0	0	0	1	1	0.00
JOURNAL DE PHYSIQUE IV	0	0	0	1	1	0.00
JOURNAL OF FUNCTIONAL ANALYSIS	0	0	0	1	1	0.00
JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS	0	0	0	1	1	0.00
JOURNAL OF NONLINEAR SCIENCE	0	0	0	1	1	0.00
JOURNAL OF THE OPTICAL SOCIETY OF AMERICA A	0	0	0	1	1	0.00
LOW TEMPERATURE PHYSICS	0	0	0	1	1	0.00
MATHEMATICAL MODELS & METHODS IN APPLIED SCIENCES	0	0	0	1	1	0.00
MATHEMATISCHE ZEITSCHRIFT	0	0	0	1	1	0.00
MEASUREMENT SCIENCE & TECHNOLOGY	0	0	1	0	1	0.00
MICHIGAN MATHEMATICAL JOURNAL	0	0	0	1	1	0.00
NEW ASTRONOMY	0	0	1	0	1	0.00
NONLINEAR ANALYSIS-THEORY METHODS & APPLICATIONS	0	0	0	1	1	0.00
PHYSICA STATUS SOLIDI B-BASIC RESEARCH	0	0	0	1	1	0.00
PHYSICS OF PLASMAS	0	0	0	1	1	0.00
PHYSICS OF THE SOLID STATE	0	0	0	1	1	0.00
PLASMA PHYSICS AND CONTROLLED FUSION	0	0	1	0	1	0.00
PROCEEDINGS OF THE AMERICAN MATHEMATICAL SOCIETY	0	0	0	1	1	0.00
RADIATION PROTECTION DOSIMETRY	0	0	1	0	1	0.00
SCIENCE IN CHINA SERIES A	0	0	1	0	1	0.00
SOLID STATE COMMUNICATIONS	0	0	0	1	1	0.00
SOVIET JOURNAL OF NUCLEAR PHYSICS-USSR	0	0	0	1	1	0.00
STUDIES IN APPLIED MATHEMATICS	0	0	0	1	1	0.00
TOHOKU MATHEMATICAL JOURNAL	0	0	0	1	1	0.00
ZEITSCHRIFT FUR PHYSIK D	0	0	1	0	1	0.00
ZHURNAL EKSPERIMENTALNOI I TEORETICHESKOI FIZIKI	0	0	0	1	1	0.00

Table 22: Authors citing high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Citing author	Number of times cited				Total
	hep-ex	hep-lat	hep-ph	hep-th	
Ellis-J	30	92	0	31	153
Banerjee-S	28	0	82	3	113
Odintsov-SD	0	0	109	0	109
Mohapatra-RN	18	0	72	12	102
Schafer-A	11	20	59	6	96
Cvetic-M	0	0	14	79	93
Heller-UM	1	63	16	12	92
Lu-H	0	0	2	88	90
Pope-CN	0	0	2	86	88
Valle-JWF	23	0	63	2	88
Barger-V	27	0	55	5	87
Thomas-AW	11	20	55	1	87
Yanagida-T	4	0	62	21	87
Tseytlin-AA	0	0	3	77	80
Dvali-G	1	0	42	36	79
Kakushadze-Z	1	0	30	47	78
Nanopoulos-DV	5	0	40	33	78
Nojiri-S	0	0	8	69	77
Riotto-A	0	2	58	16	76
Datta-A	17	0	58	0	75
Aoki-S	2	67	4	0	73
Ferrara-S	0	0	0	72	72
Hashimoto-S	2	59	11	0	72
Olive-KA	11	1	44	16	72
King-SF	11	0	48	10	69
Antoniadis-I	1	1	19	47	68
Klapdorkleingrothaus-	12	0	54	2	68
Martinelli-G	4	33	30	1	68
Simonov-YA	0	19	33	16	68
Mavromatos-NE	1	0	18	48	67
Damgaard-PH	0	25	3	38	66
Kobayashi-T	7	2	41	16	66
Kogan-II	0	2	17	47	66
Ukawa-A	1	58	5	0	64
Xing-ZZ	22	0	40	2	64
Csaki-C	1	2	27	32	62
Kanaya-K	1	56	5	0	62
Ma-E	16	0	46	0	62
Soni-A	8	10	42	2	62
Feng-JL	14	2	36	9	61
Lust-D	0	1	6	54	61
Zakharov-VI	1	20	26	14	61
Brodsky-SJ	11	1	33	15	60
Klebanov-IR	0	0	2	58	60
Kuramashi-Y	2	54	4	0	60
Faraggi-AE	2	0	26	31	59
Greiner-W	0	4	53	2	59
Smirnov-AY	17	0	40	2	59
Anselmo-F	11	0	45	2	58
Han-T	8	0	43	7	58
Verbaarschot-JJM	0	23	15	20	58
Whisnant-K	23	0	34	1	58

Citing author	Number of times cited				Total
	hep-ex	hep-lat	hep-ph	hep-th	
Yoshie-T	1	53	4	0	58
Reinhardt-H	0	17	24	16	57
Stocker-H	0	4	51	2	57
Fukugita-M	1	47	8	0	56
Iwasaki-Y	2	49	5	0	56
Zahed-I	0	12	32	12	56
Abe-K	26	0	29	0	55
Deforcrand-P	0	38	9	7	54
He-XG	11	1	38	4	54
Okawa-M	1	49	4	0	54
Rummukainen-K	1	25	23	5	54
Strumia-A	16	1	31	6	54
Vafa-C	0	0	0	54	54
Wetterich-C	1	8	28	17	54
Wilczek-F	6	7	28	13	54
Chernodub-MN	0	22	16	15	53
Ishizuka-N	1	48	4	0	53
Martin-AD	8	0	43	1	52
Rizzo-TG	11	0	28	13	52
Polikarpov-MI	0	20	14	17	51
Gibbons-GW	0	0	2	48	50
Ji-XD	4	11	32	3	50
Kim-CS	11	0	38	1	50
Laine-M	0	17	23	10	50
Murayama-H	5	0	32	13	50
Quiros-M	2	2	29	17	50
Arkanihamed-N	2	2	26	19	49
Dudas-E	2	0	21	26	49
Giusti-L	3	26	17	3	49
Kallosh-R	0	0	5	44	49
Ross-GG	2	0	33	14	49
Youm-D	0	0	9	40	49
Leontaris-GK	3	0	26	19	48
Bergshoeff-E	0	0	1	46	47
Giunti-C	18	0	29	0	47
Gonzalezgarcia-MC	14	0	33	0	47
Hollik-W	5	0	39	3	47
Ilgenfritz-EM	1	28	14	4	47
Close-FE	11	11	23	1	46
Khalil-S	9	1	29	7	46

truncated

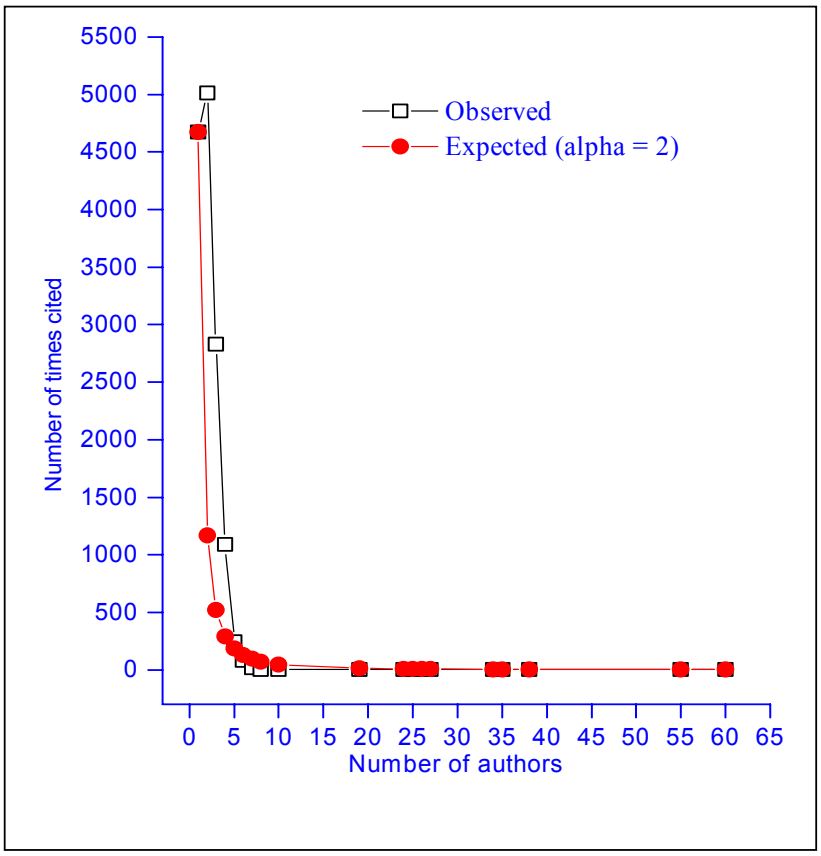

Figure 37: Lotka's Law applied to information use by authors citing the high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Table 23: Countries in the affiliation of the citing authors of high-energy physics e-print archives of LANL (1991-2002) as per *Science Citation Index* (1991-2002)

Country	Number of times cited				Total
	hep-ex	hep-lat	hep-ph	hep-th	
USA	3214	1527	1167	6566	22985
ITALY	1347	752	4999	2417	9515
GERMANY	815	930	4151	1721	7617
JAPAN	741	697	2447	1782	5667
ENGLAND	427	199	2027	1662	4315
RUSSIA	459	181	2098	1476	4214
FRANCE	368	195	1901	1291	3755
SWITZERLAND	378	262	1761	954	3355
SPAIN	217	159	1210	776	2362
PEOPLES-R-CHINA	307	97	1223	572	2199
CANADA	237	82	1012	545	1876
SOUTH-KOREA	231	18	851	754	1854
INDIA	211	54	827	576	1668
POLAND	176	52	831	281	1340
BRAZIL	124	32	531	573	1260
NETHERLANDS	97	47	505	384	1033
ISRAEL	111	29	478	291	909
TAIWAN	149	28	465	141	783
AUSTRALIA	78	125	324	157	684

Country	Number of times cited				Total
	hep-ex	hep-lat	hep-ph	hep-th	
GREECE	48	24	360	225	657
SWEDEN	51	11	280	243	585
FINLAND	50	58	329	136	573
MEXICO	62	7	268	223	560
DENMARK	16	99	228	209	552
BELGIUM	52	8	217	265	542
AUSTRIA	36	81	222	149	488
HUNGARY	51	42	271	84	448
PORTUGAL	45	10	246	94	395
ARGENTINA	27	21	140	166	354
SCOTLAND	33	93	167	57	350
UKRAINE	15	19	137	129	300
IRAN	5	0	35	254	294
CZECH-REPUBLIC	39	0	160	46	245
SLOVENIA	49	3	143	28	223
CHILE	23	4	67	126	220
TURKEY	28	3	119	66	216
NORWAY	28	9	105	52	194
IRELAND	1	16	33	116	166

Country	Number of times cited				Total
	hep-ex	hep-lat	hep-ph	hep-th	
ROMANIA	18	1	93	51	163
BULGARIA	21	0	80	60	161
SLOVAKIA	21	13	99	19	152
WALES	3	37	43	69	152
REP-OF-GEORGIA	14	0	82	40	136
ARMENIA	12	3	52	63	130
CROATIA	13	0	62	29	104
COLOMBIA	16	1	58	24	99
MOROCCO	7	2	26	46	81
CYPRUS	9	20	39	8	76
VENEZUELA	3	0	11	55	69
SOUTH-AFRICA	2	4	26	36	68
EGYPT	9	3	45	10	67
LEBANON	0	1	1	38	40
BYELARUS	6	0	22	8	36
ESTONIA	3	0	16	14	33
URUGUAY	3	5	13	11	32
ECUADOR	10	0	20	1	31
SINGAPORE	0	1	3	25	29
PAKISTAN	2	0	17	3	22
YUGOSLAVIA	0	0	4	15	19
AZERBAIJAN	1	1	13	3	18
KAZAKHSTAN	3	1	11	2	17
NEW-ZEALAND	5	2	6	4	17
VIETNAM	0	0	9	5	14
ALGERIA	1	1	2	8	12
COSTA-RICA	0	0	2	10	12
UZBEKISTAN	0	0	9	3	12
JORDAN	3	0	7	1	11
PERU	5	0	4	0	9
MOLDOVA	0	0	2	6	8
HONG-KONG	0	2	2	3	7
KYRGYZSTAN	0	0	1	6	7
SAUDI-ARABIA	3	0	3	1	7
SRI-LANKA	0	2	2	3	7
ICELAND	0	0	1	4	5
INDONESIA	1	0	4	0	5
BANGLADESH	0	0	2	1	3
BENIN	0	0	1	2	3
FED-REP-GER	0	0	0	3	3
BOSNIA-&-HERCEG	0	0	2	0	2
CUBA	0	0	2	0	2
MONGOL-PEO-REP	0	1	1	0	2
SYRIA	0	0	2	0	2
CZECHOSLOVAKIA	0	0	0	1	1
ETHIOPIA	0	0	1	0	1
GUADELOUPE	0	0	0	1	1
LIBYA	0	0	1	0	1
NEPAL	0	0	0	1	1
TUNISIA	0	0	1	0	1
USSR	0	0	0	1	1
VATICAN	0	0	0	1	1

6. CONCLUSIONS

This investigation provides evidence that e-prints are an integral component of the scholarly communication of physicists. This was especially shown to be the case for the area of high-energy particle physics. The magnitude of importance is perhaps even greater than reported as the data collected from the *Science Citation Index* (*SCI*) are likely to be an underestimation, the reason may be because of the coverage of journals by *SCI* and the reason for the citations for the e-print archives after publication may be the absence of details in the records of e-print archives. The present study shows only the trends analysis.

Among the e-print archives studied in the four different categories of high-energy physics at least 39 percentages have cited at least once from each category in *Science Citation Index* (1991-2002). The over all Gini's Coefficient was found to be 0.65. The minimum average citation to the e-print archives in the four categories was 2.73. The citing patterns of highly cited e-print archives vary widely. More than 60-70 percentages of citations are received immediately after posting the e-print archives on the site. The high-energy physics e-prints are cited heavily up to they have published in formal sources.

The Impact Factors of journals citing high-energy physics e-print archives are very high. The citing journals are very important and influential in their respective domains. *Physics Letters B*, *Physical Review D*, *Nuclear Physics B*, *Nuclear Physics B-Proceedings Supplements*, *Physical Review Letters*, *Modern Physics Letters A*, *Nuclear Physics A*, and *Classical and Quantum Gravity* are some of the most influential citing journals in the field. They are coming in some order in the highly citing journals in the four categories. There is not much relation with the Impact Factors and the number of times cited e-print archives.

The number of authors citing high-energy physics e-print archives is increasing yearly by a factor of around 1.25 increasing in the ratio. The Lotka's Law (normally is being applied for publication productivity of authors) is almost holds hood for the information use by authors in the case of citing high-energy physics e-print archives. There are many authors who are citing all the four categories of LANL high-energy physics e-print archives.

USA, Italy, Germany, Japan, England, Russia, and Switzerland are the countries occurring in the affiliation of authors citing e-print archives frequently. The researchers from these countries are more utilizing the services of LANLs high-energy physics e-print archives.

The current results also show that the level of the use and importance of e-prints to physicists because they only measure the use of e-prints by the journal literature and not the e-print literature as itself. Scientists are virtually replacing regular journal reading with daily consultation of LANL's e-print archives.

This study particularly highlights the importance of e-prints to high energy particle physicists. This microcosm within the physics community appears to be unique in its quest for up-to-the-minute research findings and in its willingness to share data before it has undergone the time honored peer review process. This self-monitoring, informal peer review by the high energy particle community ensures that the quality of their e-prints is of high caliber thereby validating the importance of e-prints in the cycle of scholarly communication.

Despite the many advantages of e-prints including: immediate; modifiable; updateable; inexpensive; unlimited size, their use has yet to overtake that of traditional journals [Brown, 2001b]. This may be a result of the policy of many journal editors and publishers disallowing manuscripts already published electronically [Harter and Park 2000; Brown 2001b; Wilkinson 2001]. In parallel, Harter [1998] found that electronic journals, which possess the same advantageous qualities as e-prints, plus the added bonus of peer-review, have not yet

made a significant impact on printed journal usage. Nonetheless, many agree with Boyce [2000] that "preprint servers are here to stay" as evidenced by their growth in other scientific disciplines [Koenig 2000; McConnell and Horton 1999; Eysenbach 2000].

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