**TITLE**

# ASSESSMENT OF INDIA'S RESEARCH LITERATURE

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## ABSTRACT

The structure and infrastructure of the India research literature was determined. A representative database of technical articles was extracted from the Science Citation Index for the years 1991, 2002, and 2005, with each article containing at least one author with an India address. Document clustering was used to identify the main technical themes (core competencies) of Indian research. Four pervasive technical topics identified from the clustering (films, alloys, crops, and infectious diseases) were analyzed further using bibliometrics, in order to identify the infrastructure of these research areas. Aggregate India bibliometrics were also performed, emphasizing the value of collaborative research to India. A unique mapping approach was used to identify networks of organizations that published together, networks of organizations with common technical interests, and especially those organizations with common technical interests that did not co-publish extensively. Finally, the citation performance of India research in myriad technical areas was compared to that of Peoples Republic of China using a novel approach.

## KEYWORDS

India; Science and Technology; Technology Assessment; Core Competencies; Research Evaluation; Metrics; Bibliometrics; Text Mining; Computational Linguistics; Document Clustering; CLUTO

# EXECUTIVE SUMMARY

## ES1. Purpose and Approach

The purposes of this study are to:

- Identify the S&T core competencies of India
- Compare representative competencies with those of at least one other country
- Generate a process that could be used efficiently and rapidly to assess the S&T core competencies in other countries of interest, including comparison with a variety of countries

The approach was to extract records with at least one Indian author from the Science Citation Index/ Social Science Citation Index (SCI/ SSCI) database, then analyze the extracted records. Two types of results are presented, bibliometrics and taxonomies. Bibliometrics provide an indication of the technical infrastructure (prolific authors, journals, institutions, citations), while taxonomies provide an indication of major technology thrusts and their relationships.

## ES2. Results

### ES2.1. Overall India Bibliometrics

#### ES2.1.1. Aggregate Publication Trends

The first metric is number of articles as a function of time. All research articles in the SCI/ SSCI having at least one author with an India address were retrieved for every fifth year from 1980-2005. The same was done for China.

***The differences between China and India are dramatic! From 1980-2005, China's research article output increased by two orders of magnitude (692 articles-72310 articles), while India's output increased by 2.5 (10606 articles-25367 articles), a factor of forty difference!***

Some strong caveats are in order at this point. Growth in SCI/ SSCI articles is a function of:

- increased research sponsorship
- increased productivity in a country
- increase in the number of journals accessed by the SCI/ SSCI

Of the top 21 journals in which Indian authors publish, the median initial journal access date (the initial date of SCI/ SSCI publication of articles from that journal) in the SCI/ SSCI was ***1970***. Of the top 20 journals in which Chinese authors publish, the median initial publication date in the SCI/ SSCI was ***1995*** (with the more recently accessed journals having relatively low Impact Factors [measures of a journal's ability to attract citations]). ***Thus, at least some of the excess growth of China's research article output relative to that of India must have come from additional journals being accessed by the SCI/ SSCI, rather than purely increased productivity or increased research sponsorship*.**

ES2.1.2. Publication Trends in High Impact Factor Journals

A very short experiment was performed (in mid-March 2006) to estimate growth of India and China articles in high Impact Factor journals. The journals cited most frequently by Indian and Chinese authors have substantial overlap. They are the well-recognized high quality journals. Three of the five most highly cited journals (one in each of the following disciplines: chemistry, physics, biology) were selected, and the numbers of papers published with India authors and with China authors were examined as a function of time. The trends are shown in Table ES1.

## TABLE ES1 – ARTICLES IN HIGH IMPACT JOURNALS VS TIME

| YEAR | JACS INDIA | CHINA | P REV LETT INDIA | CHINA | J BIO CHEM INDIA | CHINA |
|---|---|---|---|---|---|---|
| 1995 | 5 | 2 | 34 | 14 | 9 | 2 |
| 1996 | 17 | 5 | 49 | 33 | 13 | 2 |
| 1997 | 17 | 11 | 52 | 31 | 17 | 7 |
| 1998 | 23 | 12 | 66 | 56 | 10 | 7 |
| 1999 | 11 | 13 | 51 | 39 | 23 | 16 |
| 2000 | 19 | 35 | 54 | 70 | 17 | 25 |
| 2001 | 15 | 49 | 59 | 85 | 42 | 46 |
| 2002 | 14 | 45 | 49 | 82 | 31 | 56 |
| 2003 | 19 | 89 | 55 | 134 | 60 | 83 |
| 2004 | 15 | 99 | 50 | 151 | 54 | 110 |
| 2005 | 27 | 142 | 52 | 158 | 44 | 124 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2006 | 4 | 22 | 8 | 28 | 2 | 13 |

CODE:
JACS=Journal of the American Chemical Society
P REV LETT=Physical Review Letters
J BIO CHEM=Journal of Biological Chemistry

Prior to the mid-1990s, the India and China article numbers were relatively low in these journals. India had noticeably more publications in the three journals prior to about 2000. Since 2000, China has noticeably more publications than India in these journals, and the lead over India is increasing.

How does the growth in these three highly cited journals compare with the overall research article growth of India and China (shown previously) in this period? From 1995 to 2000, India's overall article growth increased by about a third (16203/ 12602). In the above table, in all three journals, India's growth over this period is greater than a third, ranging from factors of 1.5 to four. From 1995 to 2000, China's overall article growth increased by almost a factor of three (29292/ 11402). In the above table, China's increase over the same period ranged from factors of five to ten, outpacing its overall growth, and noticeably greater than India's.

From 2000 to 2005, India's overall article growth was about 50% (25367/ 16203). In the above table, India's article growth ranged from factors of zero to 2.5, on average matching its overall article growth during this period. China's overall article growth during this period was about a factor of 2.5 ((72310/ 29292), while China's article output growth in the above table ranged from factors of 2.2 to five, thereby outpacing its total article growth once again. Thus, for this admittedly limited sample of the highest cited discipline journals by China and India, ***China strongly outpaced India in growth over the time period examined, and outpaced its own overall research article growth as well.***

The message to be taken from this analysis is that ***<u>both India and China are increasing their growth of articles in highly cited journals greater than their overall increase in growth of research articles</u>.*** India's relative increase is modest, whereas China's increase is strong. For both countries, much of the increase in overall research article growth comes from increasing production of articles in low Impact Factor domestic and international journals. Also, for both countries, there is increased production in high Impact Factor journals as well. The increase in high Impact Factor journals outpaces the increase in overall research article production, but the *high Impact Factor journal production is a relatively small fraction of the overall research article production*.

ES2.1.3. Journals Containing Most India-authored Articles

For India, the highest ranking journals emphasize chemistry, veterinary, agriculture, and physics, in that order. For China, the order is physics, materials, chemistry, showing a definite difference in emphases. The only high ranking journal common to both countries is Acta Crystallographica. For India, eleven of the top 21 journals appear to be domestic Indian journals, whereas for China, ten of the top 20 journals appear to be domestic Chinese journals. In both cases, the journal Impact Factors are relatively low. For India, fifteen of the top 21 journals have Impact Factor less than unity. For China, fourteen of the top 20 journals have Impact Factor less than unity. Especially for China, almost all the journals recently accessed by the SCI/ SSCI have Impact Factors below unity. By comparison, the median Impact Factor of the 20 journals containing the most USA articles for 2005 is ***an order of magnitude higher than that of India or China***.

There are many causes that can contribute to low journal Impact Factor. These include low quality publications and/ or limited journal circulation and/ or overly applied papers and/ or technical field covered (i.e., number of researchers working in technical field and available to cite papers). This study did not distinguish among these causes for the journals listed above.

ES2.1.4. Impact of Collaboration on Journals Selected for Publication

How does collaboration among India and other countries impact the journals in which Indian authors publish? A very brief analysis was performed. Two cases were examined, and compared. The first case represents articles that could have included participation among India and other countries. The second case represents articles published essentially exclusively by India authors. The differences between the two cases represent the impact of collaboration.

In the first case, all research articles in the SCI/ SSCI having at least one author with an India address, and publication date of 2005, were retrieved. There were 25367 records. In the second case, all research articles in the

SCI/ SSCI having at least one author with an India address, a publication date of 2005, but excluding authors from (USA or Japan or Germany or Hong Kong or (England Not New England) or Canada or Italy or France or Australia or South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran) were retrieved. There were 20672 records retrieved, a 25% reduction from the collaborative case.

A small sample of high Impact Factor journals was examined. The results are unmistakable, as shown in Table ES2!

## TABLE ES2 – IMPACT OF COLLABORATION ON PUBLICATION

| JOURNAL | INDIA ONLY | INDIA & COLLAB | IMPACT FACTOR |
|---|---|---|---|
| Nature | 1 | 8 | 32.18 |
| Science | 2 | 8 | 31.85 |
| Physical Review Letters | 25 | 106 | 7.22 |
| PNAS-USA | 5 | 14 | 10.45 |

***Collaboration has the effect of dramatically increasing the presence of papers with India authors in the higher Impact Factor journals.***

ES2.1.5. Most Cited Journals

In contrast to journals containing most country papers for India and China, where only one journal was in common, there are fifteen journals in common (~3/4) out of the 20 most cited journals by each country. The Impact Factors for these most cited journals are an order of magnitude higher than the Impact Factors for the journals that contain the most India or China papers. Thus, as was the case for the China study, India authors are citing the high Impact Factor journals extensively, but not publishing in them extensively. *Both India and China authors are increasing their presence in these high Impact Factor journals, but they are presently over-concentrated in the lower Impact Factor journals*.

ES2.1.6. Most Prolific Institutions

Two institutions stand out in terms of productivity: Indian Institute of Technology (actually, an aggregate of six IITs) and Indian Institute of

Science. Of the 20 most prolific institutions, eighteen are universities, and the other twelve are research institutes, including one Chinese institute.

ES2.1.7. Cross-Institution Collaboration

Which institutes collaborate significantly on publications? To identify cross-institution collaboration, an institution-institution co-occurrence matrix was generated. The major institutional collaborators for the top five institutions are as follows (collaborator/ [# papers]):

- Indian Institute of Technology (Tata IFR [23], Bhabha ARC [20], IIS [19], NIT [14], Punjab U [11], Indira Gandhi CAR [10])
- Indian Institute of Science (IIT [19], U Madras [7], Tata IFR [6], U Mysore [5])
- Bhabha ARC (IIT [20], Banaras HU [15], Tata IFR [7], Punjab U [6])
- Univ Delhi (Tata IFR [18], Punjab U [17], IIT [5], All India IMS [5])
- Tata IFR (Punjab U [57], Chinese Acad Sci [31], IIT [23], U Delhi [18])

To display these results more graphically, an auto-correlation map of the 30 most prolific institutions (using the TechOasis software package) was generated. This map showed that no strongly connected publishing groupings are evident, but five moderately connected publishing groupings could be identified:

- University of Madras-centered group
- Punjab University-centered group
- University of Calcutta-centered group
- Bhabha ACR-centered group
- Because of its sheer magnitude, the Indian Institute of Technology has to be included as a self-contained group

Equally important, the two most prolific institutions, Indian Institute of Technology and Indian Institute of Science, were not shown connected to any other institutions, *based on the connectivity threshold necessary to display linkages*.

To obtain a more quantitative perspective on institution co-publishing relationships, a factor analysis was performed on the most prolific institutions. For the thirty most prolific institutions, a five factor institution factor matrix showed the presence of the following five distinct groupings, one for each factor.

- University of Madras strongly linked to Indian Institute of Chemical Technology, and weakly linked to Anna University, Punjab University, Tata IFR, and Chinese Academcy of Science.
- Punjab University strongly linked to Tata IFR and Chinese Academy of Science, and weakly linked to University of Delhi.
- University of Calcutta strongly linked to Jadavpur University, Saha INP, and Indian Statistical Institute, and weakly linked to Indian Association of Cultivation Science.
- Indian Institute of Technology with very weak links (same sign of factor loadings) to National Institute of Technology, University of Calcutta, Indira Ghandi ACR, and University of Madras.
- Bhabha ARC strongly linked to Banaras Hindu University and Indira Ghandi CAR, and weakly linked to Annamalai University.

Thus, the main groupings from the auto-correlation institution map are reproduced in the five factor matrix, with some additional information provided on the very weak linkages (especially for Indian Institute of Technology).

To identify institutional linkages based on common use of technical terminology (a proxy for common technical interests), an institution-phrase co-occurrence matrix was generated. The major phrases for the top five institutions are as follows (phrase, freq):

IIT (temperature 86, physics 75, water 56, synthesis 50, reaction 45, flow 44, surface 43, stability 40, structure 38, pH 38, concentration 34, compounds 33, room temperature 31, materials 31)
IIS (structure 37, temperature 28, physics 25, proteins 21, crystal structure 19, water 18, synthesis 18, surface 18, flow 16, stability 16, structures 14, species 14, protein 14, title compound 14, concentration 13, films 13, layers 13, crystal structures 13)
BhaBha (temperature 26, concentration 16, room temperature 16, structure 14, physics 13, water 12, compound 12, Au+Au collisions 12, complexes 11, reaction 10, pressure 10, pH 10, reactions 10, synthesis 9, growth 9, Co 9, particles 9, films 8, stable 8, treatment 8, ions 8)

U Delhi (complexes 18, films 16, synthesis 13, treatment 13, IR 13, Fermilab Tevatron collider 12, temperature 10, Cl 10, compounds 9, elemental analysis 9, patients 9, molar conductance 9, concentration 8, mass 8, inhibition 8, bacteria 8, NO3 8)
Tata IFR (Belle detector 31, physics 27, Fermilab Tevatron collider 15, temperature 14, magnetization 14, compounds 12, compound 10, protein 7, room temperature 7, transition 7, simulations 7, T-c 7, proteins 6, K 6, electron 6, signal 6, electrical resistivity 6, magnetic field 6)

To display these results graphically, an institution-phrase cross-correlation map was generated. This map (generated with the TechOasis software) related institutions by their common use of terminology, and thereby reflected common technical interests among institutions. *Use of this cross-correlation map in conjunction with the auto-correlation map, in addition to use of the other institutional proximity indicators, showed the importance of using multiple analytical techniques when assessing bibliometrics results.*

The institutional collaboration structure had some significant differences from the collaboration structures shown on the auto-correlation map or in the factor matrix. Most importantly, the cross-correlation map showed a bi-polar central core of Indian institutional research based on common terminology, centered about the ***highly connected*** major institutions Indian Institute of Science (basic research - proteins, crystals, microfilms) and Indian Institute of Technology (applied research - flow, simulations, macrofilms). ***On the auto-correlation map, these institutions appeared as stand-alones****, based on the threshold level of connectivity necessary for displaying linkages*!

One interpretation of the difference between the cross-correlation map structure and the previous structures is that the Indian Institute of Science and the Indian Institute of Technology are working the same general research areas as a number of other institutions, but they are not collaborating on publications to the same extent. This may be due to overlap at a generic level of technical description, but distinctness at the much more detailed level of technical description required for collaborative research and publication. Or, it may be due to a tradition of more independent research and publication practices. A more detailed examination of the collaborative practices among the institutions located in the core structure of the cross-correlation map might prove fruitful and cost-effective. ***This approach of comparing institution auto-correlation maps with institution cross-***

***correlation maps may prove to be a powerful approach for identifying institutions that are related by common interests, but are not collaborating accordingly.*** This auto/ cross-correlation map comparison approach need not be limited to institutions. It is equally applicable to authors, countries, and other categories,

From the cross-correlation map, a few other technically-based groupings can be discerned. There is a medical group (All India IMS, Postgraduate Inst MER, Central Drug Res Inst) that includes a focus on infections, the high energy physics group (common terminology of Belle Detectors, Fermilab Tevatron Collider) identified previously (Tata IFR, Panjab University, Chinese Academy of Sciences), a chemistry-oriented group (Indian Institute of Chemical Technology, University Mysore, Anna University, National Chemical Lab) emphasizing catalysis and crystal structures, and a medical lab experiment group (University of Madras, Annamalai University) that includes an emphasis on animal experiments for liver problems.

ES2.1.8. Institution Publishing Preferences

To identify preferred institutional publishing venues, an institution-journal co-occurrence matrix was generated. The major journals for the top five institutions are as follows (journal [# papers]):

- Indian Institute of Technology (Journal of Applied Physics [40], Tetrahedron Letters [18], Transactions Of The Indian Institute Of Metals [17], Physical Review B [15], Journal of Chemical Physics [13]Journal of Physical Chemistry B [12], Physica B-Condensed Matter [12], Pramana-Journal of Physics [11], Current Science [11])
- Indian Institute of Science (Physical Review B [20], ACTA Crystallographica Section E-Structure Reports Online [13], Physical Review Letters [13], Journal of Physical Chemistry B [13], Current Science [12], Pramana-Journal of Physics [10])
- Bhabha Atomic Research Center (Physics B – Condensed Matter [8], Journal of Chemical Physics [8], Journal of Physical Chemistry B [7])
- University Delhi (Spectrochimica Acta Part A-Molecular And Biomolecular Spectroscopy [13], Physical Review D [10], Current Science [9])

- TATA Inst Fundamental Res (Physical Review Letters [37], Physical Review D [22], Journal of Applied Physics [15], Physical Review B [15])

The thrusts of each institution can be seen from analysis of the leading journals in which its research is published. The Indian Institute of Technology covers a broad range of physics, chemistry, and materials, with an emphasis on physics, mainly applied. The Indian Institute of Science emphasizes the more fundamental aspects of physics, materials, and chemistry. Bhabha ARC emphasizes physics strongly, with some chemistry as well. University of Delhi emphasizes spectroscopy and physics, whereas Tata focuses very strongly on physics.

In aggregate, these five institutions have a strong focus on physics, followed by thrusts in chemistry and materials. Additionally, the journals in which they publish tend to be the more well-known higher Impact Factor journals (with some exceptions), as opposed to the low Impact Factor high frequency journals identified during the overall India publication analysis. ***This provides further evidence of the deficiencies in drawing conclusions about a country's S&T enterprise based on aggregate country bibliometrics, and suggests strongly that institution and technical discipline stratifications are important in determining quality of publication venues.***

ES2.1.9. Major Collaborating Countries

In March 2006, the SCI was accessed to identify the main collaborating countries with India on research articles, in the period 2004-2005. The results are as follows. The format is the name of the country, followed by the number of articles that contained at least one country author and one India author.

**India (46483), USA (3194), Germany (1441), Japan (1067), England (872), France (711), China (669), South Korea (553), Canada (435), Italy (419), Australia (387), Russia (316), Spain (268)**

ES2.1.10. Citation Impact of Collaboration

What is the citation impact of collaboration? Two cases were compared. The first case consisted of all research articles in the SCI published from 1995-1999 having at least one author with an India address. The second case consisted of all research articles in the SCI published from 1995-1999, retrieved using the following address query that essentially generates India-only authored articles: (India Not (USA or Japan or Germany or Hong Kong or (England Not New England) or Canada or Italy or France or Australia or South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran)) These countries were the main research collaborators with India in the 1995-1999 time frame.

The first case (India and collaborators) produced the following results:

- Articles retrieved, 76717;
- Median citations of total articles retrieved, 2;
- Median citations of top ten cited articles retrieved, 453;
- Median citations of top 5% articles retrieved, 29.

The second case (India only) produced the following results:

- Articles retrieved, 66896;
- Median citations of total articles retrieved, 2;
- Median citations of top ten cited articles retrieved, 212;
- Median citations of top 5% articles retrieved, 24.

Thus, approximately fifteen percent of research articles having at least one author with an India address were the result of India's collaboration with other countries. ***The impact of collaboration was negligible on median citations of the total retrieval. The impact of collaboration was substantial on the top ten cited articles, and was noticeable on the top 5% of cited articles.***

ES2.1.11. Main Technical Areas of Collaboration

What are the main technical areas of collaboration? The only collaboration studied was USA-India. Further, it was decided to eliminate massive multi-country studies that tend to include authors from many countries. These tend to be large drug trials, or space experiments, or astronomy experiments, etc., and the role India plays in many of these large studies is unknown. Papers that had only USA-India authors, and were published in 2005, were downloaded from the SCI/ SSCI. These papers reflect specific India-USA mutual interests. The download query used was (in the address field):

***(India and USA) not (Japan or Germany or Hong Kong or (England Not New England) or Canada or Italy or France or Australia or South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran))***

A phrase frequency analysis of the Abstracts was performed, and the highest frequency high technical content phrases were extracted. The two areas that stand out are biomedical and nanotechnology.

ES2.2. Selected Single Technology Bibliometrics

Four technical disciplines were selected to represent pervasive thrust areas of Indian research: Crops; Films; Alloys; Infectious Diseases.

ES2.2.1. Crops

For Crops, the first two journals on the prolific journals list, both Indian journals, dominate the list, and provide the impression of local relevance topics. Both journals are very applied. Only a few fundamental science journals are listed (e.g., Theoretical and Applied Genetics, Asian Journal of Chemistry), enforcing the impression of very applied research.

The most dominant Crops institution, from the perspective of numbers of publications, is the Indian Agricultural Research Institution. Of the 20 most prolific institutions, twelve are universities, and the remaining eight are research institutions. Seven of the twelve universities are agricultural universities specifically. This balance suggests relatively applied research on agriculture.

The USA is the dominant Crops collaborator by far, followed by a second tier of England, Phillipenes, Germany, and Japan. This is the first time Phillipenes has appeared in any of the most prolific country lists of the first author's text mining studies, and its presence in the midst of the high tech top tier countries stands out. The presence of Philippines in this list has strong reasons. International Rice Resarch supported by Food and Agricultural Research Organisation of the UN is in the Philippines. This is a premier international organisation in rice research. This institute has very strong linkages with Indian Agricultural Research Institute and significant collaborative research is undertaken jointly between these two organisations.

The most cited Crops journals are, on average, more fundamental than the prolific journals in the previous section. While the fraction of Indian journals is about the same in both lists, the Indian journals are lower in the rankings of the most cited.

Compared to other technical areas examined in the first author's previous text mining studies, the most cited papers in India Crops research are quite dated. Eight of the ten documents listed are pre-1980, and the remaining two were published in the 1980s. The datedness does not suggest a dynamic research field. The more field-specific documents focus on soil chemical properties, whereas the more generic documents, focus on plant molecular and cell phenomena.

ES2.2.2. Films

Based on the computational linguistics (document clustering) results, Thin Films is an important area of Indian research. Only two of the top twenty most prolific journals containing Films articles are Indian, and they are lower in the rankings. Most of the journals are applied, confirming the conclusions based on the prolific authors' institutions. The main focus is on physics, with strong emphasis on materials and chemistry as well.

Ten of the most prolific Films institutions are universities, and the remaining twelve are research centers. This provides further evidence of the applied nature of the work. Curiously, four of the institutions are nuclear/ atom research focused. Since films are surface phenomena, with charged particle and Van Der Waals forces predominating, and EV-level charged particle binding energies, why are organizations focused on nuclear forces and their associated MEV-level nuclear binding energies involved so heavily?

Three major collaborating countries stand out (USA, Germany, and Japan), with the next tier consisting of a balance of advanced Western European countries (France, England, Italy) and rapidly developing Asian countries (South Korea, Taiwan, China).

Physics journals, both basic and applied, are the most highly cited, followed by chemistry journals.

The most cited documents are much more recent than those in the Crops example. Nine of the documents are later than 1980, suggesting a much more dynamic research area. The more recent documents seem to focus on film resistance, while the older documents address the more general electronic processes in materials.

ES2.2.3. Alloys

Based on the computational linguistics (document clustering) results, Alloys is an important area of Indian research. Almost all the prolific journals listed are applied. All the top journals focus on materials, and only near the bottom of the list do more fundamental and generic journals appear (e.g., Physical Review, Bulletin of Electrochemistry).

Out of 21 institutions listed, only seven are universities. This suggests further a very applied focus. Two of the top three institutions are atomic research centers.

The major collaborating partners in Alloys are Germany and the USA, in that order. The reasons for the USA ranking second as collaborator (whereas they rank first in the other three research areas studied) are unclear, and require further study. The next tier consists of Japan and China.

While there are still a relatively large number of materials journals listed as most cited, some physics journals do appear, especially Phys Rev B (the leader), J Appl Phys, and Phys Rev Lett.

Most of the highly-cited documents are very applied and material specific. They are also much more recent than the most cited Crops papers, all Alloys papers being post-1980, with half being in the 1980s, and the remainder post-1990.

ES2.2.4. Infectious Diseases

Based on the computational linguistics (document clustering) results, Infectious Diseases is an important area of Indian research. The top three prolific journals are Indian, with an emphasis on animal infectious diseases.

Fundamental biology and other broader science disciplines are few, and rank lower on the list. None of the major science journals (Science, Nature) or medical journals (JAMA, NEJM, Lancet) are represented on this list.

Empirical evidence validates the results of computational linguistics. Anti-infectives are the largest therapeutic segment in the Indian pharmaceutical industry, accounting for 19% of market share (ICRA, 2004). Lack of:

- proper sanitation conditions,
- hygiene,
- availablilty of healthcare

had primarily contributed to the high incidence of infectious diseases in India. It is not surprising to note that international journals do not reflect Indian research on infectious diseases. There are many local/specific problems of interest to Indian journals that are not in the domain of international attention.

Fifteen institutions are research institutes, and the remaining five are universities. This imbalance suggests extremely applied research.

The USA is by far the leading collaborator, with England constituting the second tier. Japan and Germany are the third tier, well behind the second tier.

Most of the previous text mining studies of the first author have shown strong overlap between the journals containing the most papers and the most cited journals. In the present case, there is weak overlap, with only five journals (Journal Of Clinical Microbiology, Journal Of Biological Chemistry, Journal Of Infectious Diseases, Indian Journal Of Medical Research, American Journal Of Tropical Medicine And Hygience) being shared by both lists. Many of the journals uniquely contained on the most cited list are fundamental research journals, and more well-known and recognizable basic science and medical journals (Nature, Science, Lancet, NEJM are also contained on the most cited list.

Half the most cited documents are pre-1980 vintage, and these older papers focus on protein determination and analysis. Two of the more recent papers focus on tuberculosis, and the others address molecular sub-cell issues.

An interesting pattern has emerged on the most cited documents. Two of the disciplines analyzed, Crops and Infectious Diseases, represent two different aspects of the Bio category. The other two disciplines analyzed, Films and Alloys, represent two different aspects of the Physical Sciences category. The most cited papers in the Crops and Infectious Diseases disciplines tend to be quite old, and many of them are classical references with extremely large numbers of citations. The most cited papers in the Films and Alloys disciplines are of much more recent vintage, suggesting more dynamic research disciplines.

ES2.3. Aggregate Selected Technology Bibliometrics Conclusions

The four selected technologies on which the bibliometrics were performed reflected efforts at a large number of institutions. Relatively few institutions had a significant presence in more than one of these technologies. Table ES3 shows the main institutes that had a significant presence in multiple technologies. The first number in each matrix element is the number of papers published by the institution for the specific technology, and the second number is the ranking of the institution in numbers of papers for the specific technology. Thus, for example, the Indian Institute of Science published 148 papers in Films, and ranked second of all institutions publishing in Films.

## TABLE ES3 – LEADING INSTITUTIONS IN CORE COMPETENCIES

**INDIAN INSTITUTION PRESENCE IN FOUR CORE COMPETENCIES**

| INSTITUTION | CROPS | FILMS | ALLOYS | INFECT |
|---|---|---|---|---|
| Indian Institute Of Technology | 68/3 | 329/1 | 486/1 | |
| Indian Institute Of Science | | 148/2 | 129/4 | 81/3 |
| University Of Delhi | 43/9 | 64/7 | | 45/10 |
| Banaras Hindu University | 37/11 | 27/22 | 71/8 | |
| Bhabha Atomic Research Center | | 78/6 | 149/3 | |
| Indira Ghandi Center For Atomic Research | | 56/10 | 171/2 | |
| Central Electrochemical Research Institute | | 40/15 | 45/11 | |
| Tata Institute Of Fundamental Research | | 45/12 | 29/14 | |
| Shivaji University | | 60/8 | 22/21 | |
| Center For Advanced Technology | | 29/19 | 24/18 | |
| Anna University | | 27/21 | 28/16 | |

The first tier institutions, in numbers of papers, ranking, and multiple disciplines, are the Indian Institute of Technology and the Indian Institute of Science. It should be emphasized that these rankings are based on production. It should also be noted that the output of Indian Institute of Technology is aggregated output of six IITs. Quality, based on citations or other criteria, was not measured.

The second tier institutions are University of Delhi and Banares Hindu University. Both have a presence in three disciplines. The third tier contains the two atomic research centers, and the remainder of the institutions on the list constitutes the fourth tier.

A modest number of countries had significant presence in multiple disciplines. Table ES4 lists the countries, and shows the number of publications and rankings in the different disciplines. These countries are the major collaborators with India in these disciplines.

## TABLE ES4 – CORE COMPETENCY COLLABORATORS

**COLLABORATING COUNTRY PRESENCE IN FOUR CORE COMPETENCIES**

| COUNTRY | CROPS | FILMS | ALLOYS | INFECT |
|---|---|---|---|---|
| Usa | 101/1 | 101/1 | 86/2 | 186/1 |
| Germany | 22/4 | 82/2 | 104/1 | 22/4 |
| Japan | 21/5 | 67/3 | 57/3 | 26/3 |
| England | 30/2 | 27/7 | 32/5 | 54/2 |
| France | 10/10 | 49/4 | 23/6 | 17/5 |
| China | 11/8 | 19/9 | 53/4 | 14/9 |
| South Korea | 6/16 | 47/5 | 24/7 | 9/16 |
| Australia | 15/6 | 6/15 | 10/11 | 17/7 |

The first tier collaborator is clearly the USA. It ranks first in three disciplines, and second to Germany in Alloys. The second tier consists of Germany, Japan, and England. Thie third tier is France and China, followed by the fourth tier of South Korea and Australia.

The USA and Japan are relatively balanced in their presence across all disciplines. Germany and South Korea seem to emphasize the two Physical Sciences areas of Films and Alloys, whereas England and Australia place more relative emphasis on the Environmental/ Biomed areas of Crops and Infectious Diseases.

## ES2.4. Citation Comparison With China

India's research was compared with that of China, based on citations received by papers published in 1998 on myriad S&T topics. Different phrases were chosen to represent four separate research categories: Physical Sciences, Environmental/ Agricultural Sciences, Life Sciences, and Materials Sciences. Ordinarily, Engineering Sciences is used rather than Materials Sciences, but there were insufficient phrases with adequate frequencies to represent Engineering Sciences, so Materials Sciences was used instead. These four research categories are assumed to cover most of science.

Each phrase could be perceived as representing a specific technical discipline within one of the four broader categories defined above. Each phrase was used as a query, and inserted in the SCI search engine for 1998. The citation performance of the ten most cited papers for each technology for each country was compared, and the median of the top ten was the final metric employed.

The phrases (technologies) were grouped by major category. The first group is Physical Sciences. Out of twenty phrases examined, representing diverse areas of Physical Sciences, China was a clear winner in fifteen, India led in one, and four were viewed as even. Clearly, China is the leader in Physical Sciences, based on median numbers of citations.

The second group is Environmental Sciences. Out of ten phrases examined, China was the clear leader in seven, and three were considered even. Clearly, China is the leader in Environmental/ Agricultural Sciences.

The third group is Material Sciences. Out of ten phrases examined, China was the clear leader in seven, India was the clear leader in two, and one was considered even. Clearly, China is the leader in Material Sciences.

The fourth group is Life Sciences. Out of ten phrases examined, China was the clear leader in nine, and one was considered even. Clearly, China is the leader in Life Sciences.

Thus, China was the clear leader in each major category, although there were (isolated) instances where India led in a sub-technology area.

## ES2.5. Structure of India's Research Literature – Taxonomy

Figure ES1 is a four level hierarchical taxonomy of India's research literature, based on 14308 articles with Abstracts published in 2005. The themes of each level's categories and the associated numbers of records in each category are shown as follows.

### FIGURE ES1 – INDIA'S RESEARCH LITERATURE TAXONOMY

<table>
<tr><th>LEVEL 1</th><th>LEVEL 2</th><th>LEVEL 3</th><th>LEVEL 4</th></tr>
<tr><td rowspan="6">(5513) BIOMEDICAL; ENVIRON</td><td rowspan="3">(2626) BIOLOGICAL RESEARCH</td><td rowspan="2">(1458) ANIMAL EXPERIMENTS/ PLANT BIOLOGY</td><td>(807) PLANT BIOLOGY</td></tr>
<tr><td>(651) ANIMAL EXPERIMENTS</td></tr>
<tr><td colspan="2">(1168) CELL BIOLOGY/ GENETICS</td></tr>
<tr><td rowspan="3">(2887) CLINICAL MEDICINE; ENVIRON</td><td colspan="2">(1218) HUMAN PATIENT DISEASES</td></tr>
<tr><td rowspan="2">(1669) GEOLOGICAL/ MAT'L MECHANICS/ AGRICULTURAL RES</td><td>(952) SOIL/ CROP EXPERIMENTS</td></tr>
<tr><td>(717) GEOLOGICAL RES/ MATERIAL MECHANICS</td></tr>
<tr><td rowspan="7">(8795) PHYSICAL SCIENCES/ MATHEMATIC</td><td rowspan="3">(3691) MATHEMATIC</td><td colspan="2">(1372) ALGORITHMS/ NETWORK MODELING</td></tr>
<tr><td rowspan="2">(2319) MATH ANALYSIS</td><td>(1255) CONTINUUM ANALYSIS</td></tr>
<tr><td>(1064) MOLEC LEVEL CALC</td></tr>
<tr><td rowspan="4">(5104) PHYSICAL SCIENCES</td><td rowspan="2">(2867) SURF PHYS/ CHEM</td><td>(1576) FILM PHYS</td></tr>
<tr><td>(1291) FILM CHEM</td></tr>
<tr><td rowspan="2">(2237) COMPOUND CHEMISTRY</td><td>(939) CHEM BOND/ CRYS STRUCT</td></tr>
<tr><td>(1298) REACT/ CATAL/ SYNTH</td></tr>
</table>

Level 1 is divided into two categories: Biomedical/ Environment (5513) and Physical Sciences/ Mathematics (8795). The key weighted phrases and unweighted keywords are shown in parenthesis for the Level 1 categories.

**Biomedical/ Environment** covers biological and medical research, as well as agricultural and environmental research (THEMES: patient 4.0%, cell 2.0%, activ 1.7%, protein 1.7%, level 1.5%, plant 1.1%, gene 1.1%, treatment 1.0%, isol 0.9%, speci 0.8%, control 0.8%, extract 0.7%, soil 0.7%, enzym 0.7%, infect 0.7%, acid 0.6%, rat 0.6%, induc 0.6%, strain 0.6%, (22.60%); KEYWORDS biochemistry & molecular biology 402; india 251; multidisciplinary sciences 189; environmental sciences 189; food science & technology 185; chemistry, medicinal 173; biotechnology & applied microbiology 172; plant sciences 171; pharmacology & pharmacy 170; plant sciences 161; geosciences, multidisciplinary 161; surgery 154; agronomy 147; growth 147; agriculture, dairy & animal science 146; immunology 141; expression 137; pharmacology & pharmacy 134; cell biology 134; biophysics 129).

**Physical Sciences/ Mathematics** covers physics, chemistry, and mathematics, with a strong emphasis on the physics and chemistry of surfaces

(THEMES: temperatur 1.8%, model 1.4%, complex 1.4%, reaction 1.2%, structur 1.1%, phase 1.1%, ion 1.0%, film 1.0%, system 1.0%, solut 0.9%, energi 0.8%, state 0.7%, compound 0.7%, acid 0.7%, electron 0.7%, paramet 0.7%, crystal 0.7%, two 0.6%, properti 0.6%, (18.70%);
KEYWORDS: chemistry, multidisciplinary 797; chemistry, organic 642; chemistry, physical 621; materials science, multidisciplinary 538; physics, multidisciplinary 488; physics, condensed matter 324; engineering, electrical & electronic 322; polymer science 309; chemistry, inorganic & nuclear 279; physics, applied 264; crystallography 261; physics, atomic, molecular & chemical 254; chemistry, analytical 236; derivatives 212; materials science, multidisciplinary 211; behavior 201; engineering, chemical 198; model 195; systems 193; physics, condensed matter 186).

Level 4 is divided into sixteen categories, and treated as a flat taxonomy. Each category is briefly described in order of its listing in the diagram, starting from the top. The metrics, shown in the main body, have been excluded from this summary.

- **Plant Biology (807)**

This category focuses on plants and seeds, especially the extraction of oils from seeds, and has a food technology emphasis. It appears quite applied, and the main institutions are agriculture-food focused. Other Asian countries play a role equal to that of the USA, although the relatively small amount of Chinese collaboration is somewhat surprising.

- **Animal Experiments (651)**

This category focuses on laboratory experiments for addressing diseases, especially for testing the impacts of drugs. The two main institutions, University of Madras and Annamalai University were identified on Figure 2B as having common interests in liver problems especially, and this category confirms that previous finding.

- **Cell Biology/ Genetics (1168)**

This category focuses on cell biology and genetics, especially proteins and gene expression. It is one of the more fundamental research categories, as evidenced by the journals and terminology. As expected, the USA is by far the major collaborator in this fundamental research area.

- **Human Patient Diseases (1218)**

The focus here is clinical patient treatment, with emphasis on treatment of infections, especially HIV. Again, the USA is the major partner, with the Western democracies playing strong roles.

- **Soil/ Crop Experiments (952)**

The focus is study of soils and plant genetics to improve crop yields. It is more fundamental than the related Plant Biology category, as evidenced by the major journals, keywords, and institutions. The USA is a more dominant collaborator than in the Plant Biology category.

- **Geological Research/ Material Mechanics (717)**

This category has two dis-similar thrusts: Geological and associated environmental research, and the mechanics of materials. The common links that resulted in these thrusts appearing in the same category are stresses in solid materials and mechanical properties of materials. The next level of dis-aggregation would probably result in separation of these thrusts into different categories. The geological thrust focuses on sediments, and the materials thrust focuses on welding.

- **Algorithms/ Network Modeling (1372)**

Focuses on algorithms and modeling of networks, especially communications. China plays a noticeable collaborative role in this technology-oriented category.

- **Continuum Analysis (1255)**

Focuses on equations modeling continuum fields, especially flow fields and wave equations. Emphasizes mechanics, mainly fluid but some solid as well.

- **Molecular Level Calculations (1064)**

Physics-oriented category. Focuses on energy states, and calculations at the atomic and molecular level. Strong levels of co-authorship. Basic research, published in more well-known physics journals. Large international high energy physics experiments involved.

- **Film Physics (1576)**

***CATEGORY HAS TWO MAIN THRUSTS: SMALL-SCALE FILM MEASUREMENTS AND FILM DEPOSITION AND GROWTH***

**Small-Scale Film Measurements (1166 Records)**
**Film Deposition and Growth (410)**

Focuses on surface physics/ films. Main thrusts are small-scale film measurements and film deposition and growth. In both thrusts, USA is eclipsed as dominant collaborator by an Asian country.

- **Film Chemistry (1291)**

***CATEGORY HAS TWO MAIN THRUSTS: POLYMER CHEMISTRY/ PROPERTIES AND SURFACE WET CHEMISTRY***

**Polymer Chemistry/ Properties (479 Records)**

**Surface Wet Chemistry (812 Records)**

Focuses on film chemistry, mainly polymer chemistry/ properties and surface wet chemistry. Polymer work appears quite applied.

- **Chemical Bonds/ Crystal Structures (939)**

CATEGORY HAS TWO MAIN THRUSTS: LIGAND-METAL COMPLEX SYNTHESIS AND COMPOUND HYDROGEN BONDS

**LIGAND-METAL COMPLEX SYNTHESIS (460 Records)**
**COMPOUND HYDROGEN BONDS (479 Records)**

Focuses on chemical bonds and crystal structures, emphasizing ligand-metal complex synthesis and compound hydrogen bonds. Ligand-metal synthesis emphasizes domestic journals, and is relatively more applied than hydrogen bond work.

- **Reactions/ Catalysis/ Synthesis (1298)**

Applied organic chemistry category, emphasizing chemical reactions, catalysis, and synthesis.

<u>ES2.6. Relation between Expenditures and Output</u>

Finally, the relation between the research expenditures in different technical categories and the sixteen categories of research output aricles above is examined. There were four main categories of expenditures (category/ % of budget):

- Natural Sciences (21%)
- Engineering & Technology (50%)
- Medical Sciences (8%)
- Agricultural Sciences (20%)

The sixteen research output categories can be classified under the four research expenditure categories in the following very approximate manner:

- Natural Sciences (21%)
    - Continuum Analysis (1255)
    - Molecular Level Calculations (1064)
    - Film Physics (1576)
    - Film Chemistry (1291)
    - Chemical Bonds/ Crystal Structures (939)

    - Reactions/ Catalysis/ Synthesis (1298)

- Engineering & Technology (50%)
    - Geological Research/ Material Mechanics (717)
    - Algorithms/ Network Modeling (1372)

- Medical Sciences (8%)
    - Animal Experiments (651)
    - Cell Biology/ Genetics (1168)
    - Human Patient Diseases (1218)

- Agricultural Sciences (20%)
    - Plant Biology (807)
    - Soil/ Crop Experiments (952)

The relation between the percentage of expenditures assigned to the four funding categories and the percentage of articles assigned to these same categories is as follows (category name/ expenditure percent/ article percent):

- Natural Sciences (21%/ 52%)
- Engineering & Technology (50%/ 15%)
- Medical Sciences (8%/ 21%)
- Agricultural Sciences (20%/ 12%)

While different assignments of the sixteen output categories to the four expenditure categories are certainly possible (for example, one could argue that the continuum analysis category of fluid and solid mechanics is really an engineering category), nevertheless, the above imbalances are probably real. The main imbalance appears to be between the Natural Sciences and the Engineering and Technology expenditure categories. The articles in the Natural Sciences categories covered fields such as physics, chemistry, and mathematics. However, there was much applied work in each of these component fields. If the more applied research in these component fields were viewed as Technology, and transferred from the Natural Sciences category to the Engineering and Technology category, the major imbalance would be redressed substantially. In order to make this determination of basic/ applied fractions, a much larger number of research output categories (clusters) with much more narrowly defined themes would have to be generated. These smaller clusters would probably separate into basic/ applied. The present level of research output category resolution does not allow this separation.

The primary objective of this study was to examine the structure of India's research at the higher levels. Accordingly, the sixteen categories are at a relatively coarse level of resolution. In particular, much more accurate results relating research outputs to research expenditures (above) would be possible with much more well-defined categories. An assessment oriented toward more specific technology analyses would require narrower more well-defined clusters, translating into using a larger number of clusters. The present technique is fully translatable into analyzing hundreds or thousands of clusters.

# BACKGROUND

The present study combines three concepts/ approaches for the assessment of India's science and technology (S&T) literature: core competency determination, country technology assessments, and text mining assessments. This Background section addresses, in order: Core competencies, country technology assessments, text mining, and India's S&T organization.

## Core Competencies

The core competence concept was initially promulgated in 1990 as "an area of specialized expertise that is the result of harmonizing complex streams of technology and work activity" (Prahalad and Hamel, 1990). It was developed for a business context, and reflected the collective learning and coordination skills underlying a firm's product lines. According to the original proposers, core competencies are the source of competitive advantage and enable the firm to introduce an array of new products and services. They lead to the development of core products, which are then used to develop a larger number of end user products.

Since the original core competence article, many follow-on studies have been performed. Other definitions of core competence have been advanced (e.g., Galunic and Rodan, 1998). However, common features among the different core competence definitions include the following:

- Critical mass of people
- Synergy of coordinated sub-disciplines
- High quality output
- Unique capabilities
- Substantial fraction of organization's total development investment

While the original definition and most follow-on definitions have applied to business organizations, the concept can be extrapolated to nations. The five features above characterize national core competencies. In the present report, a national research core competence is defined as a technical area that

- contains a critical mass of researchers;
- consists of coordinated and synchronized sub-disciplines;

- produces high quality output;
- offers unique national capabilities;
- contains a visible fraction of research investment.

In other words, a national research core competence is a synergy of individual expertise that is aggregated and coordinated over multiple technical disciplines and is expressed as a national research strategic investment.

The text mining approach of the present report addresses a sub-set of the above features (identification of India's main research thrusts, volume of research output in main research thrusts, relative quality of selected major research thrusts) to assess potential Indian research competencies. Further subjective analysis (beyond the scope of the present report) is required to characterize the remaining necessary features of a national core competence.

This report will not discuss the desirability of employing core competencies in managing research. The first author has consulted with companies and agencies on practical aspects of implementing core competencies in research management. Within an organization, development of research core competencies tends to receive preferential and protected funding, which are very important in times of economic turndown. *Serious employee morale problems can result for those researchers who are not associated with core competence development, since they have been placed in a more vulnerable position.* The alternative, defining all the organization's development thrusts as core competencies, dilutes the purpose of utilizing core competencies to help manage research and renders them ineffective.

## Country Technology Assessments

National S&T core competencies represent a country's strategic capabilities in S&T. Knowledge of country core competencies is important for myriad reasons:

a) Awareness of priority technical areas for joint commercial or military ventures
b) Assessment of a country's military potential
c) Knowledge of emerging areas to avoid commercial or military surprise

## BACKGROUND

Obtaining such global technical awareness, especially from the literature, is difficult for multiple reasons:

a) Much science and technology performed is not documented
b) Much documented science and technology is not widely available
c) Much available documented science and technology is expensive and difficult to acquire
d) Few credible techniques exist for extracting useful information from large amounts of science and technology documentation (Kostoff, 2003)

Most credible country technology assessments are based on a combination of personal visitations to the country of interest, supplemented by copious reading of technology reports from that country. Such processes tend to be laborious, slow, expensive, and accompanied by large gaps in the knowledge available. The more credible and complete evaluation processes will focus on selected technologies from a particular country, and provide in-depth analysis.

For the past half century, driven mainly by the Cold War, a large number of country technology assessments were performed (e.g., Bostian et al (2000), Leneman (1984), Stares (1985), Hutubessy et al (2002), Mooney and Seymour (1996), McIntire (2003), Campbell et al (1985), Klinger (1990), Cohn et al (1993), Lanzerotti et al (1986), Duncan et al (1988), Spencer et al (1989), Davidson et al (1990)). The last decade has seen an expansion in focus to technologies of major economic competitors. Over the past two decades, some of the most credible of these country technology assessments have come from two organizations: World Technology Evaluation Center (WTEC-Loyola Univ) and Foreign Applied Sciences Assessment Center (FASAC-SAIC). In conducting their studies, both of these organizations would gather topical literature from the country of interest, assemble teams of experts in the topical area, have the teams review the literature as well as conduct site visitations, and have the teams brief their findings and write a final report. The studies performed by these groups remain seminal approaches to country technology assessments.

### Text Mining Technology Assessments

The first author’s group has been developing text mining approaches to extract useful information from the global science and technology literature for the past decade (e.g., Kostoff (1997), Kostoff and DeMarco (2001a), Kostoff et al (1998a, 1999, 2000a, 2000b, 2001b, 2002, 2004a, 2004b, 2004c, 2005a, 2005b, 2005c, 2005d, 2006a, 2006b, 2006c, 2006d)). These studies have typically focused on a technical discipline, and have examined global S&T efforts in this discipline. It is believed that such approaches, with slight modification, could be adapted to identifying the core S&T competencies in selected countries or regions, including estimation of the relative levels of effort in each of the core technology areas. It is also believed that coupling of the text mining approach with WTEC and FASAC approaches would amplify the strengths of each approach and reduce the limitations. The text mining component would be performed initially to identify:

- Key core competencies and technology thrusts in the country of interest
- Key interdisciplinary thrusts
- Approximate levels of efforts in technology-specific competency areas and in interdisciplinary areas
- Highly productive researchers
- Highly productive Centers of Excellence, including those not well known
- Highly cited researchers

Once the key technologies, researchers, and Centers of Excellence had been identified, then site visitation strategies could be developed. The second phase of the effort would be the actual site visitations. A key step in this hybrid process would be demonstration of the ability of text mining to identify the targets of interest with reasonable precision in a timely manner at an acceptable cost. These three driving parameters (performance, time, cost) could be traded-off against each other to provide a balance acceptable and tailored to a variety of potential customers.

The remainder of the present report is organized as follows. After a summary overview of India's S&T organizational structure, the bibliometrics and computational linguistics of India's research output are shown. These computations provide the technical infrastructure and structure of India's research literature. As part of the bibliometrics, a comparison of India's and China's citation performance for myriad sub-technologies for a vintage year is made.

## Indian Science and Technology Structure

## BACKGROUND

The next few pages summarize the S&T system in India. A much more comprehensive and thorough treatment is presented in Appendix 1.

Organizational Structure of the S&T System in India

India has a complex and multi-layered system of science and science administration consisting of: governmental agencies, autonomous institutions, university system and, industrial R&D, both in the public & private sector. Broadly, the S&T system in India can be classified under the following structures: Central (federal) Government S&T departments/agencies, State (provincial) Government S&T departments, Central Socio-economic ministries, In-house R&D in private industry, S&T in non-governmental organisations (NGOs), and Independent research institutes.

Central government S&T departments/agencies are the main instrument for providing resources and defining priorities, and they are responsible for attainments of targets in S&T in different sectors. There are 12 scientific departments/agencies mainly involved in R&D activity (R&D Statistics, 2000-01 DST):

- Department of Science and Technology (DST),
- Department of Biotechnology (DBT),
- Department of Atomic Energy (DAE),
- Department of Space (DOS),
- Defence Research and Development Organisation (DRDO),
- Department of Ocean Development (DOD),
- Department of Scientific and Industrial Research (including CSIR and two public enterprise NRDC and CEL),
- Indian Council of Agricultural Research (ICAR),
- Indian Council of Medical Research (ICMR),
- Ministry of Non-Conventional Energy Sources (MNES),
- Ministry of Communication & Information Technology (MCIT),
- Ministry of Environment & Forest (MEnF).

The five major scientific agencies DRDO, DOS, ICAR, DAE, DSIR (major funding directed to CSIR) alone accounted for 86% of the total R&D expenditure of the central governments expenditure on scientific agencies/departments (1998-99). The maximum priority was given to DRDO as it received 31.8% of the overall R&D budget. This pattern has not changed significantly in the current period as per projections available.

The main functions of these agencies are to support and coordinate research in their respective areas. This is carried out through a chain of laboratories/research institutions under them as well as through research grants/sponsored projects to higher education sector, national laboratories and establishments. The laboratories under these departments are shown in Table 1.

## TABLE 1 – SCIENTIFIC AGENCIES/ # INSTITUTES

| SCIENTIFIC AGENCY | # INST |
|---|---|
| Indian Council for Agriculture Research (ICAR) | 84 |
| Defence Research & Development Organisation (DRDO) | 53 |
| Council for Scientific & Industrial Research (CSIR) | 38 |
| Indian Council for Medical Research (ICMR) | 27 |
| Department of Science & Technology (DST) | 17 |
| Department of Atomic Energy (DAE) | 14 |
| Department of Electronics (DOE) | 14 |
| Department of Space (DOS) | 8 |
| Department of Biotechnology (DBT) | 5 |

In addition, there are research institutes under other government ministries (steel, power, railways, etc), state public sector industrial in-house R&D units, in-house R&D units of private sector, and universities contributing to research and development. 2899 institutions are estimated to be carrying out R&D activities in India. The summary of number of scientific institutions under different agencies/ministries is (Type of agency or ministry/ Number of scientific institutions):

- Central Government: R&D Institutions/laboratories; 545*

- State Government: R&D Institutions/Joint Sector Companies/ Research Stations; 777
- Universities (including 39 Deemed Universities; 11 Institutions of national importance); 226
- In-house R&D units of Private Sector and Non-Profit Research Institutions; 1351
- Total 2899

Source: S&T Data Book, 2000

*This includes 285 laboratories under the 12 scientific departments

Expenditures on R&D by field of science are shown in Table 2.

**TABLE 2 - EXPENDITURES ON R&D BY FIELD OF SCIENCE (1998-1999)**

(Rs. Lakhs)*

| Field Of Science | Central Government | State Government | Public Sector | Private Sector | Total |
|---|---|---|---|---|---|
| Natural sciences | 208890.77 (26%) | 3530.45 (3%) | 11480.54 (18%) | 32988.14 (15%) | 256889.9 (21%) |
| Engineering & Technology | 474225.85 (59%) | 4725.51 (5%) | 52541.39 (81%) | 72378.95 (32%) | 603871.7 (50%) |
| Medical Sciences | 29694.10 (4%) | 2874.15 (3%) | 1079.44 (2%) | 63512.86 (28%) | 97160.55 (8%) |
| Agricultural sciences | 92689.82 (8%) | 91523.55 (90%) | 0 | 56468.07 (25%) | 240681.44 (20%) |
| **Total** | **805500.54** | **102653.66** | **65101.37** | **225348.02** | **1198603.59** |

Note:
*1 lakh=0.1Million    Source: Constructed from DST Statistics 2000-01
45 RS. ≈ 1 US$
R&D Percentages are relative to the total expenditure in each sector. All percentages are rounded off.

It is striking to note the low levels of investment in medical science by all the different types of entities. Different priorities can be observed in terms of funding in Engineering & Technology and Agricultural Sciences by central and state government.

Actual expenditure by ministries/departments includes along with planned expenditure, non-planned expenditure and extramural funding. Thus, it is useful to observe the actual expenditure in each department to obtain proper assessment of research funding. Expenditures of 13 scientific departments/organisations for the period 2002-03 and 2003-04 are shown in Table 3.

**TABLE 3 – S&T EXPENDITURES BY VARIOUS MINISTRIES/ DEPARTMENT/ORGANISATION**

(Rupees in crore)

| S.No | Ministry/Department/Organisation | 2002-03 | 2003-04 |
|---|---|---|---|
| 1 | Atomic Energy | 6018.73 | 6148.41 |
| 2 | Space | 2162.22 | 2268.20 |
| 3. | Indian Council of Agricultural Research | 1333.96 | 1464.17 |
| 4 | Scientific and Industrial Research (including grants given to Council of Scientific and Industrial Research) | 936.71 | 1090.09 |
| 5. | Environment and Forests (including Zoological Survey of India and Botanical Survey of India) | 1057.52 | 1036.19 |
| 6 | Science and Technology including Survey of India and India Metrological Department | 920.84 | 985.84 |
| 7 | Information Technology | 497.34 | 530.62 |
| 8 | Non-Conventional Energy sources | 428.33 | 381.33 |
| 9 | Geological Survey of India (Ministry of Mines)* | 248.31 | 271.60 |
| 10 | Biotechnology | 220.70 | 262.55 |
| 11 | Indian Council of Medical Research | 180.00 | 201.86 |
| 12 | Ocean Development | 167.05 | 169.50 |
| 13 | Centre for Development of Telemetics (Department of Telecommunications)* | 108.80 | 47.66 |
| | | 14307.51 | **14858.62** |

CAG (Comptroller and Auditor General) Report: Report No. 5 of 2005 (Scientific Departments)
* They are not identified as major scientific agencies by DST- R&D Statistics (2000-01). Expenditure of DRDO (Defence Research & Development Organisation) is not covered by CAG report.

The high level of funding for the Department of Atomic Energy in comparison to other scientific agencies is evident.

## OBJECTIVES

Identify the S&T core competencies of India. Compare representative competencies with those of at least one other country. Further, generate a process that could be used efficiently and rapidly to assess the S&T core competencies in other countries of interest, including comparison with a variety of countries.

# APPROACH AND RESULTS

## 1. Overview

Two major types of information are required for a country S&T core competency assessment. One is technical infrastructure, which encompasses the prolific performers, journals that contain many of the papers, the prolific institutions, and the most cited papers/ authors/ journals. The other is technology thrusts, and the relationship among the thrusts. This study focused on obtaining both types of information.

Two types of results are presented, bibliometrics and taxonomies. Bibliometrics provide an indication of the technical infrastructure (prolific authors, journals, institutions, citations), while taxonomies provide an indication of major technology thrusts and their relationships.

Section 2 describes the database used for the bibliometrics and taxonomy analyses. Section 3 presents the bibliometrics approaches and results, where:

- Section 3.1 contains overall India bibliometrics
- Section 3.2 contains single technology bibliometrics
- Section 3.3 presents a comparison of India's and China's research using citations as the metric
- Section 4 presents the document clustering taxonomy approach and results

## 2. Databases and Information Retrieval Approach

For the present study, the Science Citation Index/ Social Science Citation Index (SCI/ SSCI) was used as the source database. The retrieved database used for analysis consists of selected journal records (including the fields of authors, titles, journals, author addresses, author keywords, abstract narratives, and references cited for each paper) obtained by searching the Web version of the SCI/ SSCI for articles that contained at least one author with an India address. The version of the SCI/ SSCI used accessed about 5600 journals (mainly in physical, environmental, engineering, and life sciences basic research).

Sample records were extracted from three different years, 1991, 2002, and 2005. Taxonomy results were obtained for those samples. There were 8025 records retrieved for 1991, of which 7108 contained Abstracts; 8035 records retrieved for 2002, of which 7499 contained Abstracts; and 15000 records retrieved for 2005, of which 14308 contained Abstracts. The Abstracts were used for the computational linguistics (phrase analyses, document clustering). For the India-China comparison, records were extracted from 1998 for each country for specific technology queries, and citations of those records compared. Finally, for the selected single technology bibliometrics analyses, records were extracted covering the time frame 2003-2005, and for the aggregate national bibliometrics, the retrieved 2005 database was used.

## 3. Bibliometrics

Two types of bibliometrics quantities will be presented: publication and citation. Publication bibliometrics are counts of papers published by different entities. These metrics can be viewed as output and productivity measures. They are not direct measures of research quality, although there is some threshold quality level inferred, since (in the present study) these papers are published in the (typically) high caliber journals accessed by the SCI/ SSCI.

Citation metrics are counts of citations to papers published by different entities. While citations are ordinarily used as impact or quality metrics (Garfield, 1985), much caution needs to be exercised in their frequency count interpretation, since there are numerous reasons why authors cite or do not cite particular papers (Kostoff, 1998b; MacRoberts and MacRoberts, 1996).

In all previous text mining studies published by the first author's group (with the exception of [Kostoff et al, 2005b, 2006c, 2006d]), bibliometrics were performed on the overall database retrieved. Since all these previous studies focused on a technology, the resultant bibliometrics provided the technical infrastructure for that technology. In the present case, the focus is on the wide range of technologies being developed within a country. A few bibliometrics are analyzed at the aggregate country level to provide insight to the distribution of technical disciplines across major institutions and journals. At the aggregate total country level, prolific institutions, collaborative countries, journals containing most Indian papers, and the most cited journals, will be presented.

Following these overall India bibliometrics, specific theme bibliometrics will be presented, using a wider variety of bibliometrics than for the overall country. At the single technology level, most cited first authors and documents will be included as well. To produce these single technology theme bibliometric analyses, the thematic thrust areas for the clustering performed in the latter part of this report are identified, then documents that address each theme are retrieved. The bibliometrics will then be performed on a theme by theme basis. For the present study, one theme is selected as an illustrative example for the bibliometrics in the main body of the text, and three other themes' bibliometrics are shown in Appendix 2.

## 3.1 Overall India Bibliometrics

This section presents temporal publication trends, journals containing most articles, journals cited most frequently by India authors, most prolific institutions, and most collaborative countries for the aggregate India database.

### 3.1.1. Publication Trends

The first metric is number of articles as a function of time. All research articles in the SCI/ SSCI having at least one author with an India address were retrieved for selected years. The same was done for China. The results (leading country first) are: (year/ number of articles):

- 1980: India [10606]; China [692]
- 1985: India [10632]; China [3115]
- 1990: India [11563]; China [7011]
- 1995: India [12602]; China [11402]
- 2000: China [29292]; India [16203]
- 2005: China [72310]; India [25367]

The differences between China and India are dramatic! From 1980-2005, China's research article output increased by two orders of magnitude, while India's output increased by 2.5, a factor of forty difference! The gross trends for some other countries are:

- South Korea (1980/ 136; 2005/ 27397);
- Taiwan (1980/ 434; 2005/ 16503);
- Brazil (1980/ 1638; 2005/ 17086).

All these countries are far smaller than India, yet their research outputs now are quite similar in magnitude, and their growths have been dramatic.

At this point, some strong caveats are in order. Many articles in the open literature imply that a country's research output growth can be represented by the growth in number of SCI/ SSCI articles. See King (2004) for perhaps the most prominent of this individually-authored genre, and the Science and Engineering Indicators (National Science Board, 2006) for the most prominent of the institutionally-authored genre. However, at a minimum, the growth in SCI/ SSCI articles is a function of:

- increased research sponsorship
- increased productivity in a country
- increase in the number of journals accessed by the SCI/ SSCI

The next bibliometrics section (Journals) contains lists of the top ~twenty journals in which India authors and China authors publish. The dates when these journals were first accessed by the SCI/ SSCI are also shown.

Of the top 21 journals in which Indian authors publish, the median initial journal access date (the initial date of SCI/ SSCI publication of articles from that journal) in the SCI/ SSCI was ***1970***. Of the top 20 journals in which Chinese authors publish, the median initial publication date in the SCI/ SSCI was ***1995*** . The more recently accessed journals have relatively low Impact Factors [measures of a journal's ability to attract citations]).

***Thus, at least some of the excess growth of China relative to India must have come from additional journals being accessed by the SCI/ SSCI, rather than purely increased productivity or increased research sponsorship.*** To understand better the breakdown among increased productivity, increased research sponsorship, and increased numbers of journals accessed, one would have to model the dynamics of publishing in detail. That was beyond the scope of this study.

However, a very short experiment was performed (in mid-March 2006) to estimate growth of India and China articles in high Impact Factor journals. As will be shown in the next bibliometrics section, the journals cited most frequently by Indian and Chinese authors have substantial overlap. They are the well-recognized high quality journals. Three of the five most highly cited journals (one in each of the following disciplines: chemistry, physics, biology) were selected, and the numbers of papers published with India authors and with China authors were examined as a function of time. Table 4 contains the results.

## TABLE 4 – INDIA-CHINA PUBLICATIONS IN SELECTED JOURNALS

| | P | J BIO |
|---|---|---|

| YEAR | JACS INDIA | CHINA | REV LETT INDIA | CHINA | CHEM INDIA | CHINA |
|---|---|---|---|---|---|---|
| 1995 | 5 | 2 | 34 | 14 | 9 | 2 |
| 1996 | 17 | 5 | 49 | 33 | 13 | 2 |
| 1997 | 17 | 11 | 52 | 31 | 17 | 7 |
| 1998 | 23 | 12 | 66 | 56 | 10 | 7 |
| 1999 | 11 | 13 | 51 | 39 | 23 | 16 |
| 2000 | 19 | 35 | 54 | 70 | 17 | 25 |
| 2001 | 15 | 49 | 59 | 85 | 42 | 46 |
| 2002 | 14 | 45 | 49 | 82 | 31 | 56 |
| 2003 | 19 | 89 | 55 | 134 | 60 | 83 |
| 2004 | 15 | 99 | 50 | 151 | 54 | 110 |
| 2005 | 27 | 142 | 52 | 158 | 44 | 124 |
| 2006 | 4 | 22 | 8 | 28 | 2 | 13 |

CODE:
JACS=Journal of the American Chemical Society
P REV LETT=Physical Review Letters
J BIO CHEM=Journal of Biological Chemistry

Prior to the mid-1990s, the numbers of India and China articles in these three journals were relatively low. Therefore, only the data from the mid-1990s to the present are presented. India had noticeably more publications in the three journals prior to about 2000. Since 2000, China has noticeably more publications than India in these journals, and the lead over India is increasing.

How does the growth in these three highly cited journals compare with the overall research article growth of India and China (shown previously) in this period? From 1995 to 2000, India's overall article growth increased by about a third (16203/ 12602). In Table 4, in all three journals, India's growth over this period is greater than a third, ranging from factors of 1.5 to four. From 1995 to 2000, China's overall article growth increased by almost a factor of three (29292/ 11402). In Table 4, China's increase over the same period ranged from factors of five to ten, outpacing its overall growth, and noticeably greater than India's.

From 2000 to 2005, India's overall article growth was about 50% (25367/ 16203). In Table 4, India's article growth ranged from factors of zero to 2.5, on average matching its overall article growth during this period. China's overall article growth during this period was about a factor of 2.5 ((72310/ 29292), while China's article output growth in Table 4 ranged from factors of 2.2 to five, thereby outpacing its total article growth once again. Thus, for this admittedly limited sample of the highest cited discipline journals by China and India, China strongly outpaced India in growth over the time period examined, and outpaced its own overall research article growth as well.

The message to be taken from this analysis is that ***both India and China are increasing their growth of articles in highly cited journals greater than their overall increase in growth of research articles*.** India's relative increase is modest, whereas China's increase is strong. For both countries, much of the increase in overall research article growth comes from increasing production of articles in low Impact Factor domestic and international journals. Also, for both countries, there is increased production in high Impact Factor journals as well. The increase in high Impact Factor journals outpaces the increase in overall research article production, but the *high Impact Factor journal production is a relatively small fraction of the overall research article production*.

In research evaluation, the highest impact/ quality research is of particular importance, since it is expected that much research (especially the riskier research) will not achieve its stated objectives. Examination of a country's performance in the high Impact Factor journals assumes increased significance for this reason. As stated before by the first author (Kostoff, 2004), overall country publication outputs can be misleading. Not only are publications in the commercially and militarily critical technologies of high importance, but as the above brief analysis has shown, publications in the high quality high Impact Factor journals are also of high importance. The data and analyses reported by King (2004) and the Science and Engineering Indicators (National Science Board, 2006) need to be upgraded to include critical technologies and high Impact Factor journals, in order to have maximum utility for country research strength evaluation purposes.

### 3.1.2. Journals

#### 3.1.2.1. Journals Containing Most India-authored Articles

The journals containing the most research articles with at least one India author (from the retrieved 2005 database) are shown on Table 5-IND. For comparison, journals containing the most research articles with at least one China author (Kostoff et al, 2006d) are shown in Table 5-CHI.

## TABLE 5-IND – JOURNALS CONTAINING MOST ARTICLES BY INDIA AUTHORS
(Retrieved 2005 database)

| JOURNAL | #PAPERS | IMPACT FACTOR | THEME |
|---|---|---|---|
| Asian Journal Of Chemistry | 290 | 0.262 | CHEM |
| Current Science | 246 | 0.688 | SCIENCE |
| Indian Veterinary Journal | 210 | 0.051 | VETER |
| Journal Of The Indian Chemical Society | 163 | 0.36 | CHEM |
| Indian Journal Of Animal Sciences | 160 | 0.067 | VETER |
| Tetrahedron Letters | 157 | 2.484 | CHEM |
| Journal Of Food Science And Technology-Mysore | 144 | 0.053 | AGRIC |
| Indian Journal Of Chemistry Section B-Organic Chemistry Including Medicinal Chemistry | 138 | 0.476 | CHEM |
| Acta Crystallographica Section E-Structure Reports Online | 127 | 0.491 | MAT'LS |
| Journal Of Applied Physics | 105 | 2.255 | PHYS |
| Physical Review B | 103 | 3.075 | PHYS |
| Indian Journal Of Agricultural Sciences | 101 | | AGRIC |
| Pramana-Journal Of Physics | 90 | 0.301 | PHYS |
| Spectrochimica Acta Part A-Molecular And Biomolecular Spectroscopy | 87 | 1.188 | CHEM |
| Journal Of The Geological Society Of India | 84 | 0.345 | GEOL |
| Indian Journal Of Physics And Proceedings Of The Indian Association For The Cultivation Of Science | 84 | | PHYS |
| Indian Journal Of Pure & Applied Physics | 79 | 0.399 | PHYS |
| Journal Of Applied Polymer Science | 79 | 1.021 | MAT'LS |
| Physical Review D | 73 | 5.156 | PHYS |
| Indian Journal Of Chemistry Section A-Inorganic Bio-Inorganic Physical Theoretical & Analytical Chem | 72 | | CHEM |
| Bulletin Of Materials Science | 72 | 0.554 | MAT'LS |

## TABLE 5-CHI – JOURNALS CONTAINING MOST ARTICLES BY CHINA AUTHORS
(Retrieved 2005 database)

| JOURNAL | #PAPERS | IMP FACT | THEME |
|---|---|---|---|
| Acta Physica Sinica | 556 | 1.25 | PHYS |
| PRICM 5: The Fifth Pacific Rim Int'l Conf On Advanced Mat'ls And Processing, Pts 1- | 520 | | MATLS |
| Chinese Physics Letters | 447 | 1.18 | PHYS |
| Acta Crystallographica Section E-Structure Reports Online | 443 | 0.49 | MATLS |
| High-Performance Ceramics III, Pts 1 And 2 | 397 | | MATLS |
| Chemical Journal Of Chinese Universities-Chinese | 338 | 0.76 | CHEM |
| Spectroscopy And Spectral Analysis | 307 | 0.35 | PHYS |
| Chinese Journal Of Analytical Chemistry | 265 | 0.41 | CHEM |
| Chinese Physics | 264 | 1.56 | PHYS |
| Rare Metal Materials And Engineering | 253 | 0.44 | MATLS |

| | | | |
|---|---|---|---|
| Acta Chimica Sinica | 253 | 0.9 | MATLS |
| Materials Letters | 242 | 1.19 | MATLS |
| Chinese Science Bulletin | 241 | 0.68 | SCIENCE |
| Journal Of Rare Earths | 237 | 0.49 | MATLS |
| Chinese Chemical Letters | 229 | 0.31 | CHEM |
| Applied Physics Letters | 219 | 4.31 | PHYS |
| Transactions Of Nonferrous Metals Society Of China | 204 | 0.28 | MATLS |
| Chinese Medical Journal | 201 | 0.46 | MED |
| Communications In Theoretical Physics | 195 | 0.87 | PHYS |
| Physics Letters A | 194 | 1.45 | PHYS |

## TABLE 5-USA – JOURNALS CONTAINING MOST ARTICLES BY USA AUTHORS

(Retrieved 2005 database)

| JOURNAL | # PAPERS | IMPACT FACTOR | THEME |
|---|---|---|---|
| Journal Of Biological Chemistry | 531 | 6.36 | CHEM |
| P Natl Acad Sci Usa | 514 | 10.45 | SCIENCE |
| Physical Review B | 499 | 3.08 | PHYS |
| Astrophysical Journal | 381 | 6.24 | PHYS |
| Journal Of Applied Physics | 348 | 2.26 | PHYS |
| J Am Chem Soc | 340 | 6.9 | CHEM |
| Physical Review Letters | 325 | 7.22 | PHYS |
| Applied Physics Letters | 306 | 4.31 | PHYS |
| Journal Of Chemical Physics | 278 | 3.11 | PHYS |
| Journal Of Virology | 268 | 5.4 | MED |
| Infection And Immunity | 207 | 4.03 | MED |
| Intl Journal Of Modern Physics A | 206 | 1.05 | PHYS |
| Geophysical Research Letters | 203 | 2.38 | GEO |
| Journal Of Physical Chemistry B | 193 | 3.83 | CHEM |
| Physical Review D | 190 | 5.16 | PHYS |
| Physical Review E | 189 | 2.35 | PHYS |
| Journal Of Neuroscience | 177 | 7.91 | MED |
| Cancer Research | 167 | 7.69 | MED |
| Health Care Financing Review | 167 | | MED |
| Nucleic Acids Research | 159 | 7.26 | MED |

For India, the highest ranking journals emphasize chemistry, veterinary, agriculture, and physics, in that order. For China, the order is physics, materials, chemistry, showing a definite difference in emphases. The only journal common to both lists is Acta Crystallographica. For India, eleven of the 21 journals listed appear to be domestic Indian journals, whereas for China, ten of the 20 journals listed appear to be domestic Chinese journals. In both cases, the journal Impact Factors are relatively low. For India, fifteen of the 21 journals listed have Impact Factor less than unity. For

China, fourteen of the 20 journals listed have Impact Factor less than unity. Especially for China, almost all the journals recently accessed by the SCI/ SSCI have Impact Factors below unity.

There are many causes that can contribute to low journal Impact Factor. These include low quality publications and/ or limited journal circulation and/ or overly applied papers and/ or technical field covered (i.e., number of researchers working in technical field and available to cite papers). This study did not distinguish among these causes for the journals listed above. As a benchmark, the journals containing the most USA publications for 2005 (based on retrieval of the 50000 most recent USA articles published in 2005) are shown in Table 5-USA, along with their Impact Factors. The medians of the Impact Factors listed for the three countries are: USA-4.74; China-.59; India-.40. ***The USA Impact Factors are an order of magnitude greater than those of China or India***, for the journals containing the most country papers.

How does collaboration among India and other countries impact the journals in which Indian authors publish? A very brief analysis was performed. Two cases were examined, and compared. The first case represents articles that could have included participation among India and other countries. The second case represents articles published essentially exclusively by India authors. The differences between the two cases represent the impact of collaboration.

In the first case, all research articles in the SCI/ SSCI having at least one author with an India address, and publication date of 2005, were retrieved. There were 25367 records. In the second case, all research articles in the SCI/ SSCI having at least one author with an India address, a publication date of 2005, but excluding authors from (USA or Japan or Germany or Hong Kong or (England Not New England) or Canada or Italy or France or Australia or South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran) were retrieved. There were 20672 records retrieved, a 25% reduction from the collaborative case.

A small sample of high Impact Factor journals was examined. Table 5-COLLAB lists these journals.

**TABLE 5-COLLAB – HIGH IMPACT FACTOR JOURNALS**
(Total 2005 records)

| JOURNAL | INDIA ONLY | INDIA & COLLAB | IMPACT FACTOR |
|---|---|---|---|
| Nature | 1 | 8 | 32.18 |
| Science | 2 | 8 | 31.85 |
| Physical Review Letters | 25 | 106 | 7.22 |
| PNAS-USA | 5 | 14 | 10.45 |

***Collaboration has the effect of dramatically increasing the presence of papers with India authors in the higher Impact Factor journals.*** The effect of collaboration on citations will be addressed in the section on collaborative countries. ***It is equally dramatic!***

3.1.2.2. Most Cited Journals

For the overall country citation metrics, the citations in all the retrieved SCI/ SSCU papers were aggregated. The journals cited most frequently were identified, and are presented in Table 6-IND in order of decreasing frequency. A similar listing of journals cited most frequently by Chinese authors was replicated from the recent China report (Kostoff et al, 2006), and is shown in Table 6-CHI.

**TABLE 6-IND – MOST CITED JOURNALS BY INDIAN AUTHORS**
(Retrieved 2005 database)

| JOURNAL | # CITES | IMP FACT | THEME |
|---|---|---|---|
| J Am Chem Soc | 5559 | 6.9 | CHEM |
| Phys Rev Lett | 4494 | 7.22 | PHYS |
| Phys Rev B | 3835 | 3.08 | PHYS |
| Nature | 3399 | 32.18 | SCIENCE |
| J Biol Chem | 3058 | 6.36 | CHEM |
| Science | 2834 | 31.86 | SCIENCE |
| Tetrahedron Lett | 2809 | | CHEM |
| J Chem Phys | 2704 | 3.11 | CHEM |
| J Org Chem | 2541 | 3.46 | CHEM |
| P Natl Acad Sci Usa | 2299 | 10.45 | SCIENCE |
| Phys Rev D | 2258 | 5.16 | PHYS |
| Inorg Chem | 2144 | 3.45 | CHEM |
| J Phys Chem-Us | 2036 | | PHYS |
| J Appl Phys | 1758 | 2.26 | PHYS |
| Appl Phys Lett | 1635 | 4.31 | PHYS |

| | | | |
|---|---|---|---|
| Chem Rev | 1558 | 20.23 | CHEM |
| Angew Chem Int Edit | 1544 | 9.16 | CHEM |
| J Phys Chem B | 1465 | 3.83 | PHYS |
| Tetrahedron | 1465 | 2.64 | CHEM |
| Phys Lett B | 1421 | 4.62 | PHYS |
| J Appl Polym Sci | 1417 | 1.021 | MAT'LS |

**TABLE 6-CHI – MOST CITED PAPERS BY CHINESE AUTHORS**
(Retrieved 2002 database)

| JOURNAL | #PAPERS | IMP FACT | THEME |
|---|---|---|---|
| Phys Rev Lett | 2592 | 7.22 | PHYS |
| J Am Chem Soc | 2196 | 6.9 | CHEM |
| Nature | 2191 | 32.18 | SCIENCE |
| Phys Rev B | 2027 | 3.08 | PHYS |
| Science | 1995 | 31.86 | SCIENCE |
| Appl Phys Lett | 1737 | 4.31 | PHYS |
| J Appl Phys | 1433 | 2.26 | PHYS |
| J Chem Phys | 1174 | 3.11 | CHEM |
| P Natl Acad Sci USA | 976 | 10.45 | SCIENCE |
| Anal Chem | 924 | 5.45 | CHEM |
| J Biol Chem | 917 | 6.36 | CHEM |
| Phys Rev D | 834 | 5.16 | PHYS |
| Phys Rev A | 779 | 2.9 | PHYS |
| Inorg Chem | 757 | 3.45 | CHEM |
| J Phys Chem-US | 738 | | PHYS |
| J Am Ceram Soc | 738 | 1.71 | MATLS |
| Macromolecules | 714 | 3.9 | CHEM |
| Angew Chem Int Edit | 687 | 9.16 | CHEM |
| Astrophys J | 641 | 6.24 | PHYS |
| J Org Chem | 612 | 3.46 | CHEM |

In contrast to journals containing most country papers (Tables 5-IND and 5-CHI), where only one journal was in common, there are fifteen journals in common (~3/4) in Tables 6-IND and 6-CHI. The Impact Factors for these most cited journals are an order of magnitude higher than the Impact Factors of the journals that contain the most India or China papers. Thus, as was the case for the China study (Kostoff et al, 2006d), India authors are citing the high Impact Factor journals extensively, but not publishing in them extensively. As was shown in the previous section, both India and China authors are increasing their presence in these high Impact Factor journals, but they are presently over-concentrated in the lower Impact Factor journals.

3.1.3. Prolific Institutions

### 3.1.3.1. List of Most Prolific Institutions

Table 7 contains a list of the thirty institutions publishing the most research articles.

## TABLE 7 – THIRTY MOST PROLIFIC INSTITUTIONS - 2005

| INSTITUTION | #PAPERS |
|---|---|
| Indian Inst Technol | 1752 |
| Indian Inst Sci | 669 |
| Bhabha Atom Res Ctr | 365 |
| Univ Delhi | 308 |
| Tata Inst Fundamental Res | 298 |
| Indian Inst Chem Technol | 262 |
| All India Inst Med Sci | 259 |
| Natl Chem Lab | 228 |
| Jadavpur Univ | 226 |
| Banaras Hindu Univ | 205 |
| Univ Madras | 205 |
| Indian Assoc Cultivat Sci | 183 |
| Anna Univ | 171 |
| Panjab Univ | 170 |
| Aligarh Muslim Univ | 154 |
| Indian Stat Inst | 147 |
| Univ Hyderabad | 145 |
| CSIR | 138 |
| Univ Calcutta | 135 |
| Natl Inst Technol | 132 |
| Postgrad Inst Med Educ & Res | 131 |
| Jawaharlal Nehru Univ | 122 |
| Cent Drug Res Inst | 119 |
| Saha Inst Nucl Phys | 113 |
| Chinese Acad Sci | 109 |
| Annamalai Univ | 107 |
| Indian Agr Res Inst | 106 |
| Indian Vet Res Inst | 99 |
| Indira Gandhi Ctr Atom Res | 99 |
| Univ Mysore | 99 |

Note: There are six Indian Institute of Technology (IIT) in the country. The numbers against IIT indicate the aggregated output of six IITs.

Two institutions stand out in terms of productivity: Indian Institute of Technology (IIT) and Indian Institute of Science. However, it should be noted that output of IIT is the total aggregate of six IITs. Eighteen are universities, and the other twelve are research institutes, including one Chinese institute.

### 3.1.3.2. Institution-Institution Co-Occurrence

Which institutes collaborate significantly on publications? To identify cross-institution collaboration, an institution-institution co-occurrence matrix was generated (using the TechOasis software). The major institutional collaborators for the top five institutions from Table 7 are as follows (collaborator/ [# papers]):

- Indian Institute of Technology (Tata IFR [23], Bhabha ARC [20], IIS [19], NIT [14], Punjab U [11], Indira Gandhi CAR [10])
- Indian Institute of Science (IIT [19], U Madras [7], Tata IFR [6], U Mysore [5])
- Bhabha ARC (IIT [20], Banaras HU [15], Tata IFR [7], Punjab U [6])
- Univ Delhi (Tata IFR [18], Punjab U [17], IIT [5], All India IMS [5])
- Tata IFR (Punjab U [57], Chinese Acad Sci [31], IIT [23], U Delhi [18])

For example, Indian Institute of Technology (aggregated output of six IITs) and Tata IFR collaborated on 23 research articles. To display these linkages/ groupings more graphically, an auto-correlation map was generated based on the institutions listed in Table 7, and will be discussed in the following section.

### 3.1.3.3. Institution Auto-Correlation Map

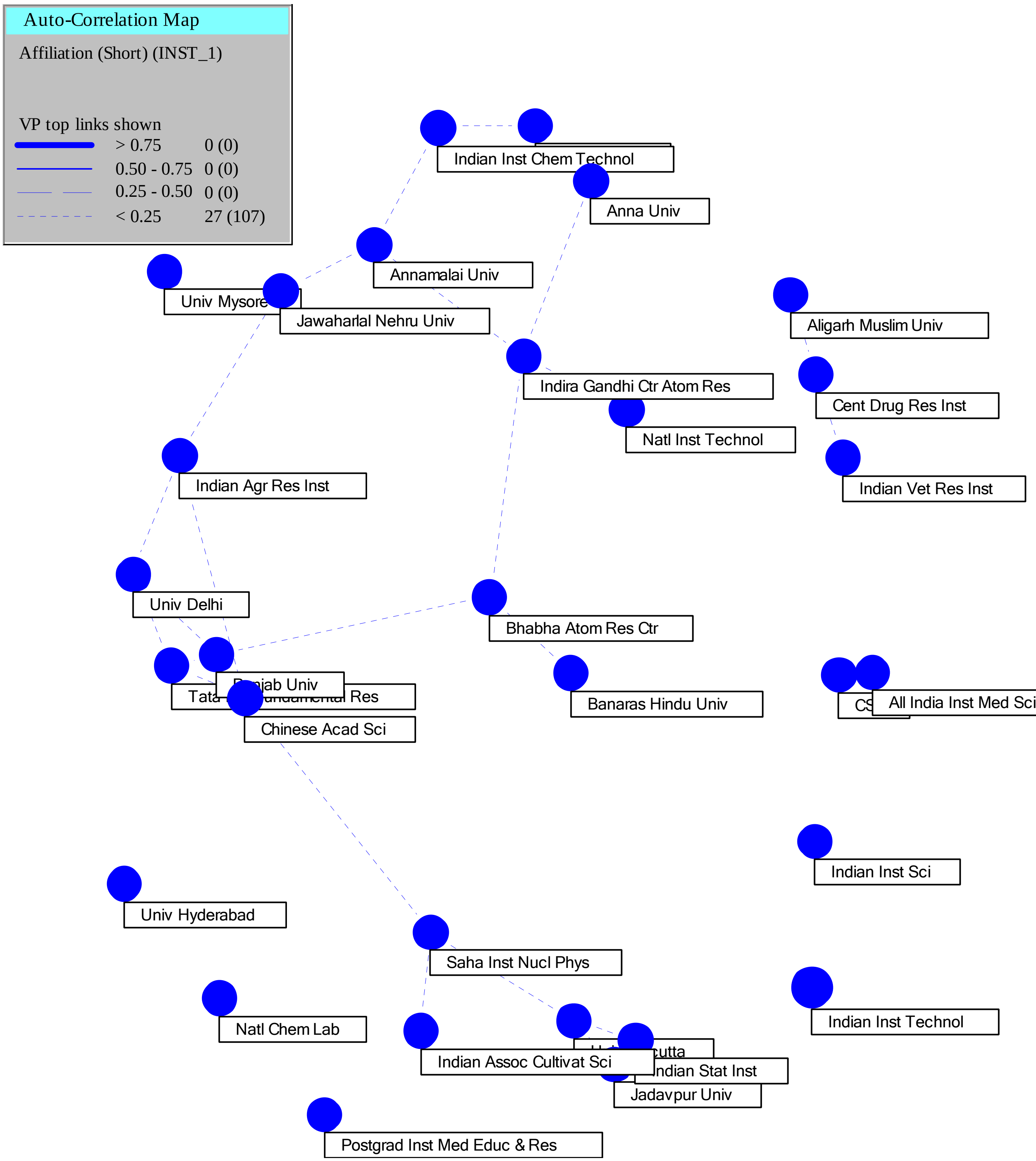
Figure 1 is an auto-correlation map of the prolific institutions listed in Table 7 (generated by the TechOasis software). No <u>strongly connected</u> publishing groupings or even linkages are evident, but five moderately connected publishing groupings can be identified:

- University of Madras-centered group (top center)
- Punjab University-centered group (mid-left)
- University of Calcutta-centered group (bottom center)
- Bhabha ACR-centered group (mid-center)
- Because of its sheer magnitude, the Indian Institute of Technology (actually, an aggregate of six IITs within the country) has to be included as a self-contained group

In addition to the intra-connection within the first four groups, there is reasonable inter-connection across these four groups evident from this diagram. However, a number of institutions, including the two most prolific producers of research articles, do not show external connections on this specific diagram, *given the selected threshold connectivity level for displaying linkages.*

**FIGURE 1 – INSTITUTION AUTO-CORRELATION MAP**
(based on thirty most prolific institutions)

## RESULTS – BIBLIOMETRICS – NATIONAL AGGREGATE



To display these groupings more quantitatively, a factor analysis was performed on the institutions listed in Table 7.

3.1.3.4. Institution Factor Matrix

Based on the thirty institutions shown in Table 7, and on the roughly five groupings discerned from the auto-correlation map of Figure 1, the five factor institution factor matrix of Table 8 was generated (using the TechOasis software). The institution names listed in Table 7 constitute the first column of Table 8, and the factors are the remaining columns. Each factor represents a 'theme', a group of institutions that co-author significantly. The matrix entries (the factor loadings) represent the contribution of the particular institution to the factor 'theme'. The main institutions in each factor (the 'theme') are those that have the highest absolute values of factor loadings. In determining the 'theme' for each factor, the factor column is sorted in both ascending and descending order. The tail with the highest absolute values of factor loadings determines the 'theme'. Typically, one tail is dominant, and there is one theme per factor. On rare occasions, the tails are of similar absolute value magnitude, and both tails are treated as separate 'themes'. The high factor loadings that determine each factor's theme are shaded darkly, and the moderate factor loadings that represent modest/ weak connectivity are shaded lightly.

**TABLE 8 – FIVE FACTOR MATRIX**
(thirty most prolific institutions)

| Factor | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Univ Madras | 0.627 | 0.272 | -0.061 | -0.104 | 0.016 |
| Indian Inst Chem Technol | 0.565 | 0.256 | -0.056 | -0.07 | 0.051 |
| Anna Univ | 0.273 | 0.122 | -0.047 | -0.082 | -0.072 |
| Panjab Univ | 0.244 | -0.68 | -0.047 | -0.05 | -0.004 |
| Tata Inst Fundamental Res | 0.218 | -0.634 | -0.026 | -0.075 | 0 |
| Chinese Acad Sci | 0.266 | -0.565 | 0.036 | -0.065 | -0.011 |
| Univ Delhi | 0.001 | -0.203 | -0.097 | 0.295 | 0.16 |
| Univ Calcutta | -0.012 | -0.012 | 0.61 | -0.129 | 0.01 |
| Jadavpur Univ | -0.038 | 0.024 | 0.544 | -0.13 | 0.047 |
| Saha Inst Nucl Phys | -0.002 | -0.051 | 0.349 | -0.026 | -0.125 |
| Indian Stat Inst | -0.022 | 0.027 | 0.329 | -0.068 | 0.084 |
| Indian Assoc Cultivat Sci | -0.018 | 0.02 | 0.226 | 0.097 | 0.014 |
| Indian Inst Technol | -0.339 | -0.002 | -0.298 | -0.71 | 0.169 |
| Natl Inst Technol | -0.072 | 0.009 | -0.114 | -0.148 | -0.021 |
| Bhabha Atom Res Ctr | -0.13 | -0.056 | -0.021 | 0.026 | -0.582 |
| Banaras Hindu Univ | -0.118 | -0.023 | -0.037 | 0.129 | -0.495 |

| | | | | | |
|---|---|---|---|---|---|
| Indira Gandhi Ctr Atom Res | 0.022 | 0.058 | -0.118 | -0.104 | -0.39 |
| Annamalai Univ | 0.119 | 0.078 | -0.047 | 0.098 | -0.278 |
| Jawaharlal Nehru Univ | 0.018 | 0.02 | 0.003 | 0.201 | -0.085 |
| Univ Mysore | -0.014 | 0.023 | -0.013 | 0.133 | -0.034 |
| Aligarh Muslim Univ | -0.062 | 0.006 | -0.025 | 0.146 | -0.008 |
| Indian Vet Res Inst | -0.042 | 0.008 | -0.015 | 0.159 | 0.004 |
| Cent Drug Res Inst | -0.082 | 0.002 | -0.021 | 0.186 | 0.013 |
| Indian Agr Res Inst | -0.017 | -0.033 | -0.033 | 0.196 | 0.028 |
| Univ Hyderabad | 0.019 | 0.026 | -0.021 | 0.049 | 0.037 |
| Postgrad Inst Med Educ & Res | -0.01 | 0.003 | 0.039 | 0.08 | 0.043 |
| Indian Inst Sci | 0.001 | 0.068 | -0.044 | 0.158 | 0.047 |
| Natl Chem Lab | -0.058 | 0.022 | -0.045 | 0.027 | 0.108 |
| CSIR | -0.061 | 0.006 | -0.046 | 0.217 | 0.251 |
| All India Inst Med Sci | -0.082 | 0.004 | -0.073 | 0.306 | 0.285 |

Five distinct groupings are shown, one for each factor.

- University of Madras strongly linked to Indian Institute of Chemical Technology, and weakly linked to Anna University, Punjab University, Tata IFR, and Chinese Academcy of Science.
- Punjab University strongly linked to Tata IFR and Chinese Academy of Science, and weakly linked to University of Delhi.
- University of Calcutta strongly linked to Jadavpur University, Saha INP, and Indian Statistical Institute, and weakly linked to Indian Association of Cultivation Science.
- Indian Institute of Technology with very weak links (same sign of factor loadings) to National Institute of Technology, University of Calcutta, Indira Ghandi ACR, and University of Madras.
- Bhabha ARC strongly linked to Banaras Hindu University and Indira Ghandi CAR, and weakly linked to Annamalai University.

Thus, the main groupings from the auto-correlation institution map are reproduced in the five factor matrix, with some additional information provided on the very weak linkages (especially for Indian Institute of Technology).

Table 8 was based on the top thirty research article-producing institutions only. However, this base of institutions may not be sufficiently broad to display some of the more interesting institutional linkages. To incorporate more institutions into the analysis, while retaining mostly domestic institutions, a factor matrix based on the sixty most prolific research article producers was generated, and is shown in Table 9. The software default of eight institutions was selected. As a rule of thumb, selecting the square root of the variables as the number of factors produces reasonable results.

## TABLE 9 – EIGHT FACTOR MATRIX

(sixty most prolific institutions)

| FACTOR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Jadavpur Univ | 0.54 | 0.08 | -0.03 | 0.04 | -0.07 | 0.06 | -0.04 | 0.06 |
| Univ Calcutta | 0.54 | 0.06 | -0.03 | 0.04 | -0.06 | 0.05 | -0.08 | 0.07 |
| Indian Inst Chem Biol | 0.36 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.07 | 0.05 |
| Indian Stat Inst | 0.29 | 0.06 | -0.02 | 0.04 | -0.04 | 0.03 | -0.06 | 0.02 |
| Saha Inst Nucl Phys | 0.28 | -0.06 | 0.01 | 0.02 | -0.03 | -0.02 | -0.01 | 0.07 |
| Indian Assoc Cultivat Sci | 0.22 | -0.08 | 0.03 | 0.00 | 0.01 | -0.04 | -0.02 | 0.01 |
| Inst Phys | 0.02 | -0.72 | -0.01 | 0.04 | -0.09 | 0.02 | -0.02 | 0.06 |
| Univ Rajasthan | 0.02 | -0.69 | 0.00 | -0.01 | -0.05 | 0.02 | -0.01 | 0.04 |
| Korea Univ | -0.04 | 0.00 | -0.83 | 0.01 | 0.02 | -0.35 | 0.12 | 0.05 |
| Inst High Energy Phys | -0.04 | -0.20 | -0.83 | 0.02 | 0.03 | -0.33 | 0.06 | 0.06 |
| Princeton Univ | -0.03 | -0.02 | -0.82 | 0.02 | 0.05 | -0.34 | -0.08 | 0.01 |
| Univ Tokyo | -0.03 | 0.09 | -0.66 | -0.01 | -0.12 | -0.28 | 0.22 | 0.06 |
| Panjab Univ | -0.01 | -0.28 | -0.58 | 0.02 | 0.03 | -0.22 | -0.12 | 0.01 |
| Chinese Acad Sci | 0.02 | 0.14 | -0.49 | 0.00 | -0.14 | -0.19 | 0.01 | -0.02 |
| Tata Inst Fundamental Res | 0.00 | 0.03 | -0.48 | 0.05 | 0.04 | -0.19 | -0.15 | 0.01 |
| Indian Inst Chem Technol | -0.05 | -0.04 | -0.02 | -0.61 | -0.03 | 0.06 | -0.09 | -0.01 |
| Univ Madras | -0.06 | 0.01 | -0.01 | -0.55 | -0.04 | 0.05 | -0.11 | 0.20 |
| Karnatak Univ | 0.00 | -0.02 | 0.02 | -0.24 | -0.01 | -0.04 | -0.02 | -0.01 |
| Bharathidasan Univ | -0.04 | 0.05 | -0.02 | -0.22 | -0.06 | 0.06 | -0.03 | 0.17 |
| Sri Venkateswara Univ | -0.02 | -0.02 | 0.04 | -0.20 | -0.02 | -0.10 | -0.06 | -0.07 |
| Univ Delhi | -0.02 | -0.06 | -0.09 | 0.03 | 0.71 | -0.06 | -0.10 | 0.03 |
| Natl Phys Lab | -0.04 | -0.02 | 0.02 | 0.04 | 0.61 | 0.00 | -0.06 | 0.10 |
| Univ Allahabad | -0.02 | 0.01 | 0.01 | 0.02 | 0.22 | 0.01 | 0.05 | 0.04 |
| Jawaharlal Nehru Univ | 0.00 | 0.03 | 0.01 | -0.02 | 0.11 | 0.02 | 0.03 | 0.02 |
| Indian Inst Sci | -0.05 | 0.04 | 0.30 | 0.02 | -0.11 | -0.67 | -0.11 | 0.12 |
| Jawaharlal Nehru Ctr Adv Sci Res | -0.02 | 0.01 | 0.26 | 0.06 | -0.07 | -0.60 | -0.06 | 0.15 |
| Banaras Hindu Univ | -0.02 | 0.02 | -0.03 | 0.01 | 0.00 | -0.02 | 0.64 | 0.16 |
| Bhabha Atom Res Ctr | -0.02 | -0.20 | -0.01 | 0.03 | -0.04 | -0.02 | 0.55 | 0.17 |
| Osmania Univ | -0.03 | -0.04 | -0.01 | -0.13 | -0.05 | 0.02 | 0.04 | -0.40 |
| Natl Geophys Res Inst | -0.03 | -0.02 | -0.02 | -0.06 | -0.06 | 0.01 | 0.04 | -0.39 |
| Natl Inst Oceanog | -0.02 | 0.00 | 0.01 | 0.02 | -0.02 | -0.03 | 0.00 | -0.27 |
| Univ Hyderabad | -0.04 | -0.02 | 0.00 | -0.01 | -0.08 | 0.00 | -0.04 | -0.25 |
| Phys Res Lab | -0.02 | -0.04 | 0.00 | 0.04 | -0.10 | -0.01 | -0.02 | -0.25 |
| Cochin Univ Sci & Technol | -0.09 | 0.03 | 0.05 | 0.06 | -0.05 | -0.11 | -0.03 | -0.15 |
| CSIR | -0.03 | 0.02 | 0.01 | 0.01 | 0.07 | -0.01 | -0.02 | -0.15 |
| All India Inst Med Sci | -0.02 | 0.01 | 0.01 | 0.02 | 0.11 | 0.02 | 0.02 | -0.14 |
| Cent Food Technol Res Inst | -0.01 | 0.01 | 0.02 | 0.01 | 0.02 | -0.02 | 0.09 | -0.12 |
| Cent Drug Res Inst | -0.02 | 0.05 | 0.00 | 0.05 | 0.05 | 0.04 | 0.17 | -0.10 |
| Guru Nanak Dev Univ | -0.03 | 0.00 | -0.01 | 0.01 | -0.02 | 0.03 | -0.06 | -0.10 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Natl Chem Lab | -0.03 | 0.03 | 0.00 | 0.06 | -0.04 | 0.03 | -0.03 | -0.10 |
| Christian Med Coll & Hosp | 0.03 | 0.02 | 0.00 | 0.01 | 0.02 | 0.02 | 0.02 | -0.10 |
| Sanjay Gandhi Postgrad Inst Med Sci | -0.02 | 0.03 | 0.00 | 0.03 | 0.02 | 0.03 | 0.09 | -0.09 |
| Postgrad Inst Med Educ & Res | 0.11 | 0.01 | -0.01 | 0.01 | 0.01 | 0.03 | 0.01 | -0.09 |
| Maharaja Sayajirao Univ Baroda | -0.01 | 0.00 | 0.00 | 0.01 | -0.01 | 0.02 | 0.06 | -0.08 |
| Reg Res Lab | -0.08 | 0.03 | -0.02 | -0.04 | -0.04 | 0.05 | -0.08 | -0.08 |
| Punjabi Univ | -0.02 | -0.10 | -0.06 | 0.03 | -0.03 | 0.02 | -0.04 | -0.07 |
| Aligarh Muslim Univ | -0.02 | 0.04 | 0.00 | 0.04 | 0.02 | 0.04 | 0.10 | -0.07 |
| Punjab Agr Univ | 0.00 | 0.02 | 0.00 | 0.01 | 0.01 | 0.02 | 0.03 | -0.06 |
| Univ Mysore | -0.02 | 0.02 | 0.04 | -0.02 | 0.01 | -0.07 | 0.07 | -0.06 |
| Indian Vet Res Inst | -0.01 | 0.03 | 0.01 | 0.01 | 0.05 | 0.02 | 0.10 | -0.06 |
| Andhra Univ | -0.04 | 0.01 | 0.01 | -0.04 | -0.03 | 0.00 | 0.01 | -0.05 |
| Indian Agr Res Inst | 0.00 | 0.03 | 0.00 | 0.01 | 0.11 | 0.02 | 0.03 | -0.04 |
| Ind Technol Inst | -0.03 | 0.03 | 0.03 | 0.05 | -0.02 | -0.05 | -0.03 | 0.02 |
| Madurai Kamaraj Univ | -0.01 | 0.02 | -0.01 | -0.08 | 0.00 | 0.03 | 0.00 | 0.02 |
| Natl Inst Technol | -0.10 | 0.03 | -0.01 | 0.10 | -0.07 | 0.08 | -0.02 | 0.06 |
| Annamalai Univ | -0.08 | 0.05 | 0.00 | -0.13 | 0.00 | 0.05 | 0.07 | 0.11 |
| Indira Gandhi Ctr Atom Res | -0.16 | 0.07 | 0.00 | 0.02 | -0.07 | 0.07 | 0.13 | 0.17 |
| Cent Leather Res Inst | -0.09 | 0.07 | -0.03 | -0.07 | -0.07 | 0.11 | -0.11 | 0.20 |
| Anna Univ | -0.08 | 0.08 | -0.03 | -0.19 | -0.06 | 0.11 | -0.05 | 0.23 |
| Indian Inst Technol | -0.29 | -0.02 | -0.06 | 0.44 | -0.22 | 0.29 | -0.30 | 0.29 |

Rather than address each of the eight factors in detail, only the differences with the five factor case will be discussed. Factor 2 of Table 9 (Institute of Physics and University of Rajasthan) is new. Factor 3 of Table 9 shows the larger context of Factor 2 of Table 8. Factor 3 represents international collaboration probably in high energy physics (based on the institutions listed). Factor 5 of Table 9 (University of Delhi and National Physics Lab) has been added. Factor 6 of Table 9 is similar to that of Factor 3, but shows more clearly the additional linkages of Indian Institute of Science and Jawaharlal Nehru CASR to the international high energy physics collaboration. Factor 8 on Table 9 shows the addition of an environmental-based research group. Obviously, if more institutions were included in this analysis, and more factors, then more detailed relationships could be portrayed.

While this section and the previous two sections portray institutional linkages from a number of perspectives, they offer little insight as to why the institutions are linked; in particular, what are the technical themes on which the linked institutions collaborate. The next series of results attempts to portray linkages based on commonality of subject matter, and provides another important piece to the puzzle.

### 3.1.3.5. Institution-Phrase Co-Occurrence

To identify institutional linkages based on common use of technical terminology, an institution-phrase co-occurrence matrix was generated (using the TechOasis software). The major phrases for the top five institutions are as follows (phrase, freq):

IIT (temperature 86, physics 75, water 56, synthesis 50, reaction 45, flow 44, surface 43, stability 40, structure 38, pH 38, concentration 34, compounds 33, room temperature 31, materials 31)
IIS (structure 37, temperature 28, physics 25, proteins 21, crystal structure 19, water 18, synthesis 18, surface 18, flow 16, stability 16, structures 14, species 14, protein 14, title compound 14, concentration 13, films 13, layers 13, crystal structures 13)
BhaBha (temperature 26, concentration 16, room temperature 16, structure 14, physics 13, water 12, compound 12, Au+Au collisions 12, complexes 11, reaction 10, pressure 10, pH 10, reactions 10, synthesis 9, growth 9, Co 9, particles 9, films 8, stable 8, treatment 8, ions 8)
U Delhi (complexes 18, films 16, synthesis 13, treatment 13, IR 13, Fermilab Tevatron collider 12, temperature 10, Cl 10, compounds 9, elemental analysis 9, patients 9, molar conductance 9, concentration 8, mass 8, inhibition 8, bacteria 8, NO3 8)
Tata IFR (Belle detector 31, physics 27, Fermilab Tevatron collider 15, temperature 14, magnetization 14, compounds 12, compound 10, protein 7, room temperature 7, transition 7, simulations 7, T-c 7, proteins 6, K 6, electron 6, signal 6, electrical resistivity 6, magnetic field 6)

While some overlap appears between Tata and Delhi on the high energy physics terminology, other overlaps among institutions appear only on very generic terminology. More institutions, more detailed phrases, and a more intuitive display are required to gain a better understanding of the bases for inter-institutional collaboration. The next section presents such an approach.

### 3.1.3.6. Institution-Phrase Cross-Correlation Map

To display these linkages among institutions more visually, two cross-correlation maps were generated (using the TechOasis software) that show institutional relationships based on use of common terminology (Figures 2A and 2B). The first map, Figure 2A, includes very generic technical phrases. Because of their universal use in many papers, these generic phrases tend to blur the differentiation among papers from a grouping/ clustering perspective. The second map, Figure 2B, does not include these general terms as stand-alone phrases (but they may be included as part of a larger phrase), and does include more detailed lower frequency phrases.

**FIGURE 2A – INSTITUTION-PHRASE CROSS-CORRELATION MAP (**Generic Phrases Retained)

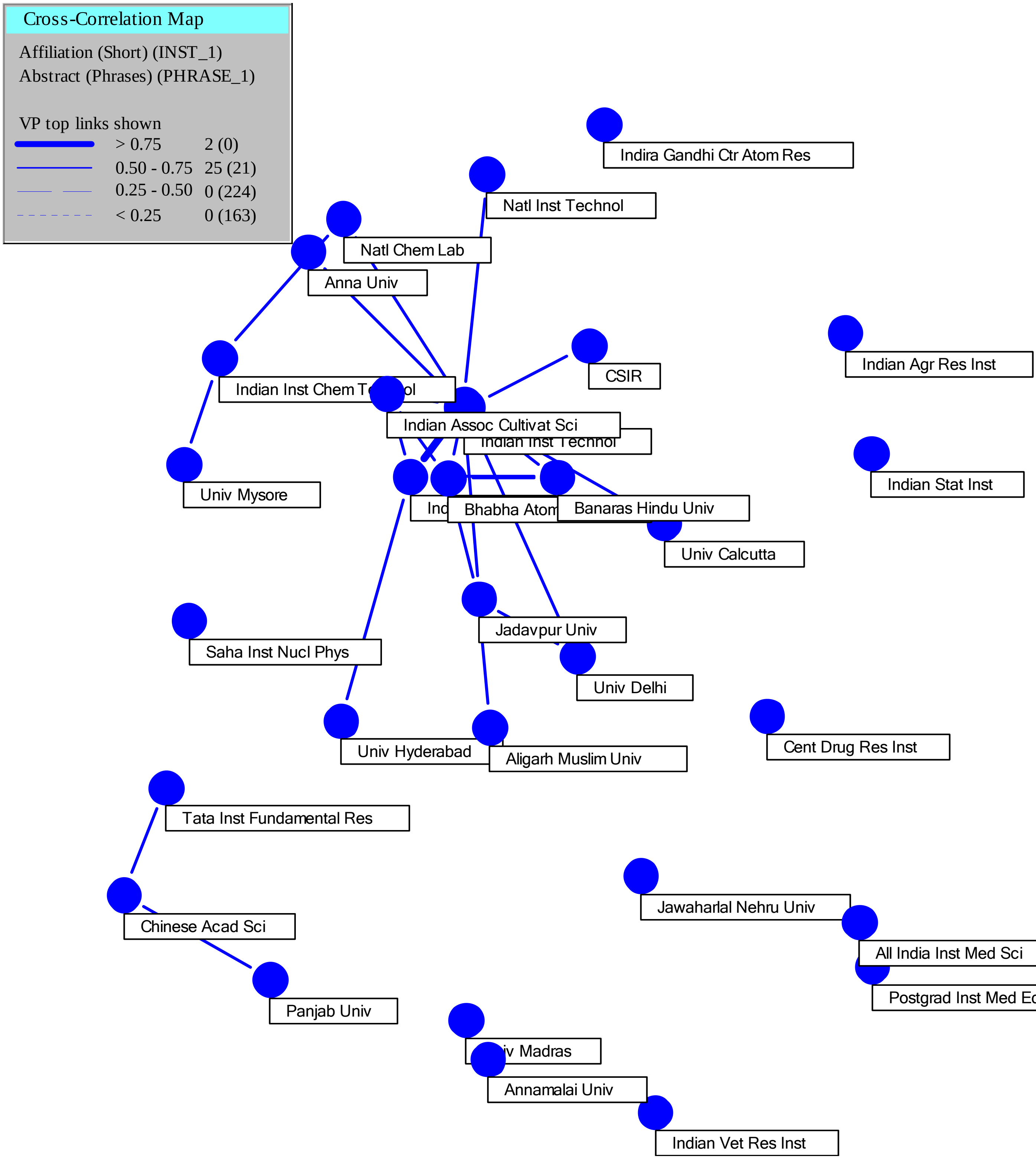
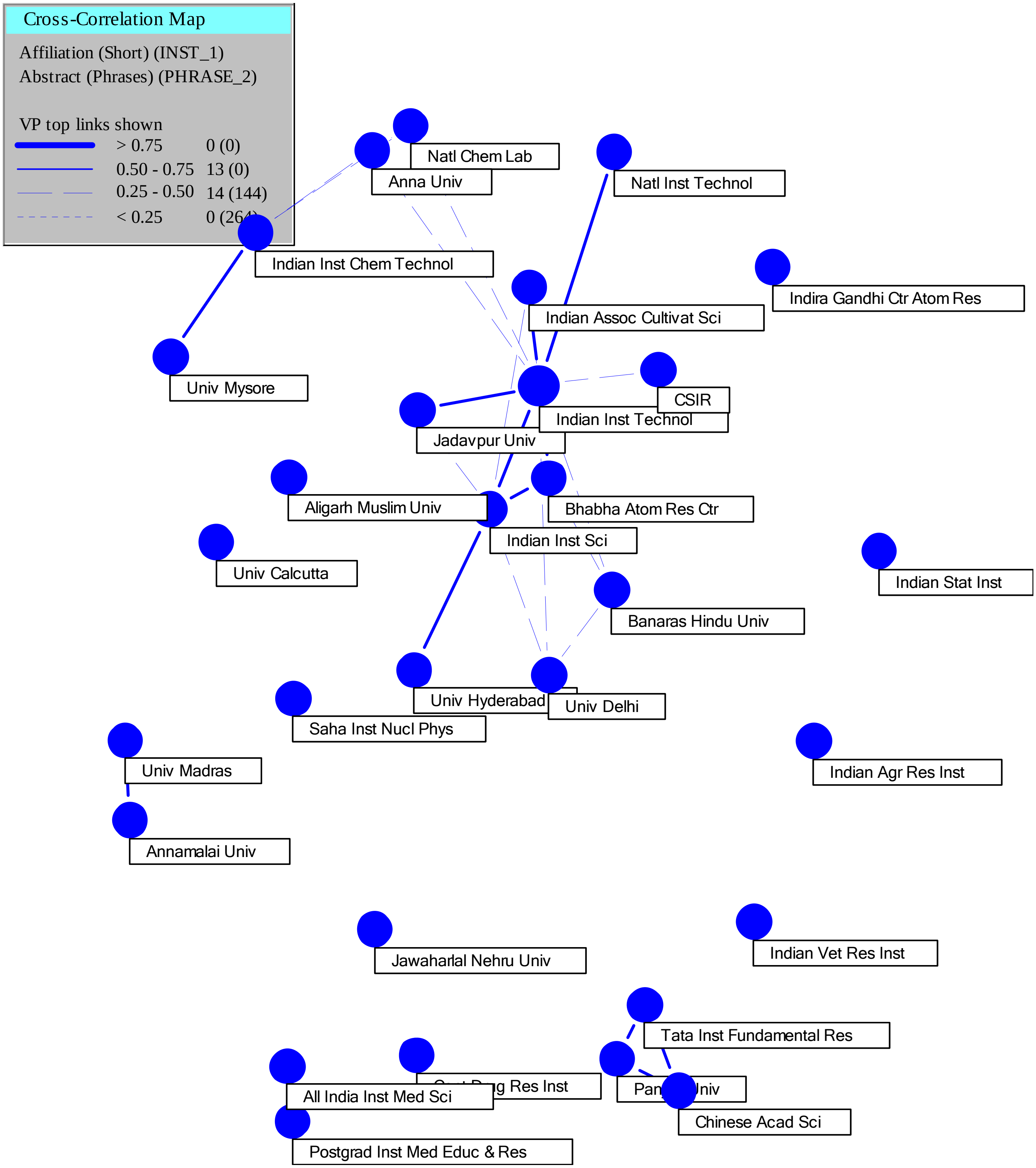


**FIGURE 2B – INSTITUTION-PHRASE CROSS-CORRELATION MAP (**Generic Phrases Removed**)**



One immediately observable difference between the institution auto-correlation map and the institution-phrase cross-correlation maps is the number of displayed linkages and the strength of the linkages. Because of the binding effect of the generic phrases, Figure 2A shows more internal linkages and stronger internal linkages than does Figure 2B.

However, Figure 2B shows the importance of using multiple analytical techniques when assessing bibliometrics results. The institutional collaboration structure has some significant differences from the collaboration structures shown previously. Most importantly, Figure 2B shows a bi-polar central core of Indian institutional research based on common terminology, with the more basic research centered about the Indian Institute of Science (e.g., proteins, crystals, microfilms) and the more applied research centered about the Indian Institute of Technology (e.g., flow, simulations, macrofilms).

One interpretation of the difference between the structure on 2B and the previous structures is that the Indian Institute of Science and the Indian Institute of Technology are working the same general research areas as a number of other institutions, but they are not collaborating on publications to the same extent. This may be due to overlap at a generic level of technical description, but distinctness at the much more detailed level of technical description required for collaborative research and publication. Or, it may be due to a tradition of more independent research and publication practices. A more detailed examination of the collaborative practices among the institutions located in the core structure of Figure 2B might prove fruitful and cost-effective. ***This approach of comparing institution auto-correlation maps with institution cross-correlation maps may prove to be a powerful approach for identifying institutions that are related by common interests, but are not collaborating accordingly.*** This auto/ cross-correlation map comparison approach need not be limited to institutions. ***It is equally applicable to authors, countries, and other categories.***

From Figure 2B, a few other technically-based groupings can be discerned. There is a medical group at bottom center (All India IMS, Postgraduate Inst MER, Central Drug Res Inst) that includes a focus on infections, the high energy physics group (common terminology of Belle Detectors, Fermilab Tevatron Collider) at bottom right identified previously (Tata IFR, Panjab University, Chinese Academy of Sciences), a chemistry-oriented group at upper left (Indian Institute of Chemical Technology, University Mysore, Anna University, National Chemical Lab) emphasizing catalysis and crystal structures, and a medical lab experiment group at lower left (University of Madras, Annamalai University) that includes an emphasis on animal experiments for liver problems.

3.1.3.7. Institution-Journal Co-Occurrence

Finally, to identify preferred institutional publishing venues, an institution-journal co-occurrence matrix was generated. The major journals for the top five institutions are as follows (journal [# papers]):

- Indian Institute of Technology (Journal of Applied Physics [40], Tetrahedron Letters [18], Transactions Of The Indian Institute Of Metals [17], Physical Review B [15], Journal of Chemical Physics [13]Journal of Physical Chemistry B [12], Physica B-Condensed Matter [12], Pramana-Journal of Physics [11], Current Science [11])
- Indian Institute of Science (Physical Review B [20], ACTA Crystallographica Section E-Structure Reports Online [13], Physical Review Letters [13], Journal of Physical Chemistry B [13], Current Science [12], Pramana-Journal of Physics [10])
- Bhabha Atomic Research Center (Physics B – Condensed Matter [8], Journal of Chemical Physics [8], Journal of Physical Chemistry B [7])
- University Delhi (Spectrochimica Acta Part A-Molecular And Biomolecular Spectroscopy [13], Physical Review D [10], Current Science [9])
- TATA Inst Fundamental Res (Physical Review Letters [37], Physical Review D [22], Journal of Applied Physics [15], Physical Review B [15])

The thrusts of each institution can be seen from analysis of the leading journals in which its research is published. The Indian Institute of Technology covers a broad range of physics, chemistry, and materials, with an emphasis on physics, mainly applied. The Indian Institute of Science emphasizes the more fundamental aspects of physics, materials, and chemistry. Bhabha ARC emphasizes physics strongly, with some chemistry as well. University of Delhi emphasizes spectroscopy and physics, whereas Tata focuses very strongly on physics.

In aggregate, these five institutions have a strong focus on physics, followed by thrusts in chemistry and materials. Additionally, the journals in which they publish tend to be the more well-known higher Impact Factor journals (with some exceptions), as opposed to the low Impact Factor high frequency journals identified during the overall India publication analysis. This provides further evidence of the deficiencies in drawing conclusions about a country's S&T enterprise based on aggregate country bibliometrics, and suggests strongly that institution and technical discipline stratifications are important in determining quality of publication venues.

### 3.1.4. Collaborative Countries

In March 2006, the SCI was accessed to identify the main collaborating countries with India on research articles, in the period 2004-2005. The results are as follows. The format is the name of the country, followed by the number of articles that contained at least one country author and one India author.

> **India (46483), USA (3194), Germany (1441), Japan (1067), England (872), France (711), China (669), South Korea (553), Canada (435), Italy (419), Australia (387), Russia (316), Spain (268)**

What is the citation impact of collaboration? Two cases were compared. The first case consisted of all research articles in the SCI published from 1995-1999 having at least one author with an India address. The second case consisted of all research articles in the SCI published from 1995-1999, retrieved using the following address query that essentially generated India-only authored articles: (India Not (USA or Japan or Germany or Hong Kong or (England Not New England) or Canada or Italy or France or Australia or South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran)) These countries were the main research collaborators with India in the 1995-1999 time frame.

The first case (India and collaborators) produced the following results:

- Articles retrieved, 76717;
- Median citations of total articles retrieved, 2;
- Median citations of top ten cited articles retrieved, 453;

- Median citations of top 5% articles retrieved, 29.

The second case (India only) produced the following results:

- Articles retrieved, 66896;
- Median citations of total articles retrieved, 2;
- Median citations of top ten cited articles retrieved, 212;
- Median citations of top 5% articles retrieved, 24.

Thus, approximately fifteen percent of research articles having at least one author with an India address were the result of India's collaboration with other countries. The impact of collaboration was negligible on median citations of the total retrieval. The impact of collaboration was substantial on the top ten cited articles, and was noticeable on the top 5% of cited articles.

What are the main technical areas of collaboration? The only collaboration studied was USA-India. Further, it was decided to eliminate massive multi-country studies that tend to include authors from many countries. These tend to be large drug trials, or space experiments, or astronomy experiments, etc., and the role India plays in many of these large studies is unknown. Papers that had only USA-India authors, and were published in 2005, were downloaded from the SCI/ SSCI. These papers reflect specific India-USA mutual interests. The download query used was (in the address field):

***(India and USA) not (Japan or Germany or Hong Kong or (England Not New England) or Canada or Italy or France or Australia or South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran))***

A phrase frequency analysis of the Abstracts was performed, and the highest frequency high technical content phrases were extracted. The results are as follows.

**Triple Word Phrases**

(Transmission Electron Microscopy; Cancer Cell Lines; Cox-2 Inhibitory Activity; Red Blood Cells; High Molecular Weight; Ifn- Gamma Assay; Kg Body Weight; Molecular Weight Napss; Scanning Electron Microscopy;

Van Der Waals; Tobacco Use Prevention; Atomic Force Microscopy; Density Functional Theory; Differential Scanning Calorimetry; Dry Deciduous Forests; Fatigue Crack Growth; Human Immunodeficiency Virus; Indian Summer Monsoon; Infants With Pvg; Superoxide Dismutase Sod; Topoisomerase Ii Alpha; Ad Hoc Networks; Bay Of Bengal; Central Nervous System; Electron Microscopy Tem; Fourier Transform Infrared; Lead And Cadmium; Magnesium Alloy Metal; Neoformans Var Grubii; Scfa Exposed Cells; Sn-119 Mossbauer Spectroscopic; Absorption Of Sumatriptan; Alloy Metal Matrix; Coefficient Of Friction; Cox-2 Over Cox-1; Dna Polymerase Beta; Gluteal Adipose Tissue; Health Care Workers; Immunodeficiency Virus Hiv; Mixed Deciduous Forests; Multitemperature Plasma Model; Nitric Oxide Synthase; Polymerase Chain Reaction; Prevalence Of Diabetes; Reactive Oxygen Species; Single Crystal X-Ray; Summer Monsoon Season)

**Double Word Phrases**

(X-Ray Diffraction; Electron Microscopy; Black Hole; Cell Lines; Crystal Structure; Risk Factors; Hydrogen Bonds; Molecular Weight; Oxidative Stress; Summer Monsoon; Topoisomerase Ii; Amino Acid; Body Weight; Lipid Peroxidation; Room Temperature; Sex Workers; Thin Films; Transmission Electron; Breast Cancer; Cancer Cell; Gene Expression; Inhibitory Activity; Particle Size; Scanning Electron; Indian Ocean; Monte Carlo; Mycobacterium Tuberculosis; Space Group; Strain Rate; Transition Temperature; Deciduous Forests; Density Functional; Neural Network; Allergic Rhinitis; Blood Lead; Cell Line; Heat Sink; Magnetic Field; Mass Spectrometry; Hydrogen Bonding; Immune Response; Lung Cancer; Magnetic Resonance; Mechanical Properties; Superoxide Dismutase; Western Ghats; Adipose Tissue; Blood Cells; Cancer Cells; Cellular Networks; Cox-2 Inhibitory; Cross Sections; Glutathione Gsh; Health Care; Ifn- Gamma; Magnesium Alloy; Nitric Oxide; Red Blood; Solid State)

**Single Word Phrases**

(Patients; Cells; Temperature; Phase; Protein; Cell; Surface; Treatment; Energy; Acid; Reaction; Expression; Proteins; Gene; Species; Dna; Molecular; Magnetic; Population; Water; Compounds; Human; Algorithm; Rats; Infection; X-Ray; Cancer; Binding; Electron; Vitro; Drug; Films; Tobacco; Alloy; Blood; Clinical; Health; Lead; Network; Genes; Assay; Mice; Strains; Brain; Ions; Metal; Physics; Plasma; Hydrogen)

Representative phrases are selected, and the phrases are ordered by frequency of occurrence. <u>The two areas that stand out are biomedical and nanotechnology.</u>

## 3.2 Single Technology Bibliometrics

### 3.2.1 Publication Statistics on Authors, Journals, and Organizations

The first group of metrics presented is counts of papers published by different entities. These metrics can be viewed as output and productivity measures. They are not direct measures of research quality, although there is some threshold quality level inferred, since these papers are published in the (typically) high caliber journals accessed by the SCI/ SSCI.

Based on the computational linguistics (clustering) results in Section 4, Crops is a thrust area of Indian research. Starting with the words generated by the clustering algorithm for the Crops cluster, an iterative feedback approach was used to generate the following comprehensive query for this research in India:

"(crop or crops or rice or wheat or (irrigation and soil) or sorghum or groundnut or maize or soybean or intercropping or sowing or grain yield or planting or tillage or millet or fruit or farmyard or agricultur* or potato) not (diet or diets or sensory or meals or dessert or fat* or frying or fried or (dried and fruit) or liver or diabetes or metabolism or arthritis or enteritis or fermentation or cancer or (heart and disease))"

The query was inserted into the SCI/ SSCI, and the most recent 1984 research articles (records) were recovered for the period 2003-early 2005. The bibliometrics analysis was performed on these records.

#### 3.2.1.1. Prolific Authors

**TABLE 10 - PROLIFIC AUTHORS – CROPS – 2003-2005**

| AUTHOR | INSTITUTION | #PAPERS |
|---|---|---|
| Singh--S | Chaudhary Charan Singh Haryana Agr Univ | 42 |
| Kumar--A | Chaudhary Charan Singh Haryana Agr Univ | 36 |
| Kumar--S | Chaudhary Charan Singh Haryana Agr Univ | 35 |
| Singh--R | Project Directorate Cropping Syst Res | 30 |
| Singh--B | Natl Bur Plant Genet Resources | 25 |
| Kumar--R | Cent Potato Res Inst | 23 |
| Singh--J | Guru Nanak Dev Univ | 21 |
| Singh--AK | Indian Agr Res Inst | 20 |
| Singh--N | Guru Nanak Dev Univ | 20 |
| Singh--P | Cent Inst Cotton Res | 20 |

| | | |
|---|---|---|
| Singh--G | Arid Forest Res Inst | 17 |
| Singh--RP | Directorate Wheat Res | 16 |
| Sharma--RK | Directorate Wheat Res | 15 |
| Sharma--A | CSKHPKV | 14 |
| Singh--KP | Ind Toxicol Res Ctr | 14 |
| Kumar--D | Narendra Deva Univ Agr & Technol | 13 |
| Sharma--SK | Rajasthan Agr Univ | 13 |
| Singh--A | Rajasthan Agr Univ | 13 |
| Singh--H | Punjab Agr Univ | 13 |
| Singh--M | Indian Inst Soil Sci | 13 |

Table 10 contains the most prolific authors. Out of the 20 authors listed, nine are from research institutions under the Indian Council of Agricultural Research (ICAR) and eight are from Agricultural Universities supported by ICAR. This indicates that majority of the authors belong to places supported by ICAR. This balance seems to imply very applied research.

However, the results illustrate potential problems with author bibliometrics in countries like India (and China). The names are short, common, and many do not have middle initials. In Table 10, there are only three different surnames listed. For example, Singh is a very common Indian name. The first name listed, Singh S, could include a few other people with the same common name. Because of the potential ambiguity in names, this table will not be used for further analysis.

3.2.1.2. Journals Containing Most Papers

## TABLE 11 – JOURNALS CONTAINING MOST CROPS' PAPERS

| JOURNAL | # PAPERS |
|---|---|
| Indian Journal Of Agricultural Sciences | 437 |
| Indian Journal Of Agronomy | 207 |
| Current Science | 59 |
| Journal Of Food Science And Technology-Mysore | 42 |
| Plant Breeding | 24 |
| Plant Science | 23 |
| Food Chemistry | 22 |
| Journal Of Plant Biochemistry And Biotechnology | 21 |
| Theoretical And Applied Genetics | 20 |
| Agricultural Water Management | 20 |
| Field Crops Research | 20 |
| Indian Journal Of Animal Sciences | 19 |
| Annals Of Arid Zone | 17 |

| | |
|---|---|
| Euphytica | 17 |
| Biologia Plantarum | 16 |
| Bioresource Technology | 15 |
| Crop Protection | 14 |
| Communications In Soil Science And Plant Analysis | 14 |
| Asian Journal Of Chemistry | 13 |
| Journal Of Plant Nutrition And Soil Science-Zeitschrift Fur Pflanzenernahrung Und Bodenkunde | 12 |
| Journal Of Agronomy And Crop Science | 12 |
| Journal Of Food Engineering | 12 |
| Journal Of Tropical Forest Science | 12 |
| Journal Of Scientific & Industrial Research | 12 |

TABLE 11 lists the 24 journals containing the most Crops papers. The first two journals on the list, both Indian journals, dominate the list, and provide the impression of local relevance topics. Both journals are very applied. It is interesting to observe Current Science- a multidisciplinary Indian journal covered by SCI/ SSCI, is in the third rank. It plausibly indicates that crop researchers are addressing issues that reach out to a larger audience. Another multi-disciplinary journal, Scientific & Industrial Research is also in the list. Only a few fundamental science journals are listed (e.g., Theoretical and Applied Genetics, Asian Journal of Chemistry), further re-enforcing the impression of very applied research.

3.2.1.3. Most Prolific Institutions

## TABLE 12 – PROLIFIC CROPS' INSTITUTIONS

| INSTITUTION | #PAPERS |
|---|---|
| Indian Agr Res Inst | 176 |
| Chaudhary Charan Singh Haryana Agr Univ | 81 |
| Punjab Agr Univ | 77 |
| Indian Inst Technol | 68 |
| Tamil Nadu Agr Univ | 66 |
| Univ Agr Sci | 57 |
| Govind Ballabh Pant Univ Agr & Technol | 53 |
| Int Crops Res Inst Semi Arid Trop | 52 |
| Univ Delhi | 43 |
| Cent Food Technol Res Inst | 40 |
| Banaras Hindu Univ | 37 |
| Rajasthan Agr Univ | 30 |

| | |
|---|---|
| Guru Nanak Dev Univ | 29 |
| Cent Arid Zone Res Inst | 28 |
| Int Rice Res Inst | 22 |
| Natl Bot Res Inst | 21 |
| Indian Inst Hort Res | 21 |
| Univ Mysore | 20 |
| Indira Gandhi Agr Univ | 17 |
| Cent Potato Res Inst | 17 |

The 20 most prolific institutions are listed in Table 12. Most dominant is the Indian Agricultural Research Institute. Twelve of the institutions are universities, and the remaining eight are research institutions. Seven of the twelve universities are agricultural universities specifically. The presence of Indian Institute of Technology (IIT-there are six IITs in India) being in the fourth position points out to the interdisciplinarity in crop research. IITs are primarily technical schools. They also have interdisciplinary departments such as bio-physics, etc. This balance suggests relatively applied research on agriculture.

3.2.1.4. Most Prolific (collaborating) Countries

Table 13 contains the countries listed in the record address field.

TABLE 13 – COLLABORATING COUNTRIES

| COUNTRY | # PAP |
|---|---|
| India | 1984 |
| USA | 101 |
| England | 30 |
| Philippines | 28 |
| Germany | 22 |
| Japan | 21 |
| Australia | 15 |
| Canada | 13 |
| Peoples R China | 11 |
| Netherlands | 11 |
| France | 10 |
| Scotland | 8 |
| Nigeria | 8 |
| Iran | 7 |
| Mexico | 7 |
| Spain | 7 |
| South Korea | 6 |
| Nepal | 6 |
| Sweden | 5 |

| | |
|---|---|
| Vietnam | 5 |
| Wales | 5 |

The USA is the dominant collaborator by far, followed by a second tier of England, Philippines, Germany, and Japan. This is the first time Philippines has appeared in any of the most prolific country lists of the first author's text mining studies, and its presence in the midst of the high tech top tier countries stands out. The presence of Philippines in this list has strong reasons. International Rice Resarch supported by Food and Agricultural Research Organisation of the UN is in the Philippines. This is a premier international organisation in rice research. This institute has very strong linkages with Indian Agricultural Research Institute and significant collaborative research is undertaken jointly between these two organisations.

### 3.2.2. Citation Statistics on Authors, Journals, and Documents

#### 3.2.2.1. Most Cited First Authors

**TABLE 14 – MOST CITED FIRST AUTHORS - CROPS**

| AUTHOR | #CITES |
|---|---|
| Jackson Ml | 118 |
| *Aoac | 84 |
| Gomez KA | 64 |
| Murashige T | 61 |
| Lowry OH | 58 |
| Singh S | 58 |
| Singh G | 53 |
| Kumar A | 52 |
| Snedecor GW | 50 |
| Sambrook J | 46 |
| Thomas P | 46 |
| Walkley A | 45 |
| *Fao | 44 |
| Singh RP | 43 |
| Olsen SR | 42 |
| Singh R | 39 |
| Yadav Rl | 38 |
| Aulakh MS | 35 |
| Singh J | 34 |
| Panse VG | 34 |

The presence of Jackson, Gomez, Murashige, Sambrook, and Olsen can be correlated with their appearance as first authors in the most cited documents list (Table 16). As already pointed out, it is difficult to specify a unique author from an Indian name. In a plausible future study, linking the author names with institution address can be undertaken to reduce the noise.

3.2.2.2. Most Cited Journals

## TABLE 15 – MOST CITED JOURNALS - CROPS

| JOURNAL | #CITES |
|---|---|
| Theor Appl Genet | 608 |
| Plant Physiol | 591 |
| Indian J Agron | 580 |
| Crop Sci | 490 |
| Plant Soil | 400 |
| Cereal Chem | 356 |
| Indian J Agr Sci | 338 |
| Soil Sci Soc Am J | 320 |
| Soil Biol Biochem | 292 |
| J Indian Soc Soil Sc | 288 |
| P Natl Acad Sci USA | 285 |
| Nature | 251 |
| Physiol Plantarum | 244 |
| Phytopathology | 237 |
| J Biol Chem | 232 |
| J Agr Food Chem | 231 |
| Agron J | 226 |
| Science | 215 |
| Euphytica | 188 |
| Plant Cell | 180 |

The most cited journals are, on average, more fundamental than the prolific journals in the previous section. While the fraction of Indian journals is about the same in both lists, the Indian journals are lower in the rankings of the most cited. From the two tables it can also be observed that journals attracting maximum publications as given in the previous section (i.e. ranked in the order of intensity of publication) have much lower Impact Factors then journals that are highly cited.

3.2.2.3. Most Cited Documents

## TABLE 16 – MOST CITED DOCUMENTS - CROPS

| DOCUMENT | #CITES | #CITES-SCI |
|---|---|---|

| | | |
|---|---|---|
| Jackson Ml, 1967/ 1973, Soil Chem Anal | 72 | 599 |
| **Soil Chemical Analysis** | | |
| Murashige T, 1962, Physiol Plantarum, V15, P473 | 57 | 22261 |
| **A Revised Medium For Rapid Growth And Bio Assays With Tobacco Tissue Cultures** | | |
| Lowry Oh, 1951, J Biol Chem, V193, P265 | 54 | >65000 |
| **Protein Measurement With The Folin Phenol Reagent** | | |
| Gomez Ka, 1984, Stat Procedures Agr | 37 | 1979 |
| **Statistical Procedures For Agricultural Research** | | |
| Sambrook J, 1989, Mol Cloning Lab Manu | 35 | >112000 |
| **Molecular Cloning: Laboratory Manual** | | |
| Walkley A, 1934, Soil Sci, V37, P29 | 34 | 2160 |
| **Examination Of Degtjareff Method For Determining Soil Organic Matter And A Proposed Modification Of The Chromic Acid Titration Method** | | |
| Laemmli Uk, 1970, Nature, V227, P680 | 32 | >65000 |
| **Cleavage Of Structural Proteins During Assembly Of Head Of Bacteriophage-T4** | | |
| Bradford Mm, 1976, Anal Biochem, V72, P248 | 32 | >65000 |
| **Quantitation Of Microgram Quantities Of Protein Utilizing Principle Of Protein-Dye Binding** | | |
| Olsen Sr, 1954, 939 Usda | 21 | 1973 |
| **Estimation Of Available P In Soil By Extraction With Sodium Bicarbonate** | | |
| Subbiah Bv, 1956, Curr Sci, V25, P259 | 20 | 216 |
| **A Rapid Procedure For The Estimation Of Available Nitrogen In Soils** | | |

In Table 16, the full or abbreviated document title is in CAPS, following each citation. Two citation numbers are listed for each document. The first (# CITES) is the citations from the retrieved papers only. These can be viewed as Crop-specific citations. The second (# CITES-SCI) are the total citations received by the paper as listed in the SCI/ SSCI. They cover all succeeding years from the document publication date, and all disciplines.

Compared to other technical areas examined in previous text mining studies, the most cited papers in India Crops research are quite dated. Eight of the ten documents listed are pre-1980, and the remaining two were published in the 1980s. The datedness does not suggest a dynamic research field. The more field-specific documents, where the ratio of # CITES/ # CITES-SCI is more than a few percent, focus on soil chemical properties, whereas the more generic documents, where the ratio is about a percent or less, focus on plant molecular and cell phenomena.

## 3.3. Citation Comparison with China

It was desired to compare India's research with that of at least one other country. China was chosen as a country with many similar characteristics to India (large population, rapidly developing economy, rapid growth in research, etc), and was used as a basis for comparison.

In a previous text mining assessment of Finland (Kostoff et al, 2006c), the research impact was compared to that of two other countries, Mexico (subject of a prior country text mining assessment) and Switzerland (representing an advanced technology country). Two technical areas were arbitrarily selected, the quantitative and qualitative attributes of the ten most cited and ten least cited papers from a vintage year were compared, and conclusions were drawn about relative impact. It was decided to use a somewhat broader approach for comparison in the present India study. More technical disciplines would be examined from a citation perspective, but less detail would be presented for each comparison. First, some background discussion.

In evaluating research impact, there are three main criteria to consider: 'right job', 'job right', 'productivity/ progress'. 'Right job' refers to proper selection of the broadest objectives; i.e., is the right study being pursued? Addressing this metric tends to require evaluation of a country's overall investment strategy. "Job right' refers to selection of the best approaches to solving the problem to reach the desired goal. 'Productivity/ progress' refer to whether anything tangible is being accomplished.

A detailed determination of 'right job' using citation statistics would require clustering the vintage papers thematically, examining citation ranges for each cluster (theme), then assuming that those themes that had the highest citations were the 'hot' research areas. The papers that were in the 'hot' clusters would get high ratings for the 'right job' criterion. The 'job right' rating for any of the papers would be determined by its citation position within any of the clusters. However, for this initial country application of the new comparison approach, the first two criteria are combined, and the overall citation statistics for a number of competitive research disciplines will be compared for the two countries.

For the present comparison, 1998 was chosen as the vintage year. It was of sufficient vintage that a substantial number of citations could have had time to accumulate, but sufficiently recent to relate to current research quality. Additionally, the total SCI papers for each country for 1998 were of relatively similar magnitude (India, 16228 research articles; China, 18830 research articles). Equal numbers of records for India and China (3500) were downloaded from the SCI. Phrases and their frequencies were extracted from each country's download, and combined. Identical phrases were grouped, and their ratios of frequencies were computed.

It was desired to select phrases representing significant technical disciplines with similar levels of emphasis, and since the total published records for each country for 1998 in SCI were within about ten percent, a factor of about two difference in phrase frequency for a technical discipline was viewed as the outer bound of similar emphasis. Thus, those phrases with both high frequencies of occurrence and frequency ratios within a factor of two were extracted, and examined. Different phrases were chosen to represent four separate research categories: Physical Sciences, Environmental/ Agricultural Sciences, Life Sciences, and Materials Sciences. Ordinarily, Engineering Sciences is used rather than Materials Sciences, but there were insufficient phrases with adequate frequencies to represent Engineering Sciences, so Materials Sciences was used instead. These four research categories are assumed to cover most of science.

Each phrase could be perceived as representing a specific technical discipline within one of the four broader categories defined above. Each phrase was used as a query, and inserted in the SCI search engine for 1998. The total SCI citations for the retrieved records for each country for each phrase from 1998-mid 2005 were tabulated and analyzed. The results are shown in Table 17.

## TABLE 17 – INDIA/ CHINA CITATION COMPARISON

| TOPIC 1998 RECORDS | INDIA RECORDS RETRIEVED | INDIA CITES TEN-MED | CHINA RECORDS RETRIEVED | CHINA CITES TEN-MED | WINNER |
|---|---|---|---|---|---|
| **PHYSICAL SCIENCES** | | | | | |
| CRYSTAL* | 1096 | 68 | 1923 | 96 | CHI+ |
| FILM* | 665 | 50 | 1319 | 58 | CHI |
| OXIDATION | 555 | 37 | 501 | 47 | CHI + |
| CATALYST OR CATALYSIS OR CATALYTIC | 468 | 45 | 615 | 67 | CHI ++ |
| ALGORITHM* | 322 | 33 | 505 | 36 | EVEN |
| NUCLEAR | 310 | 35 | 365 | 48 | CHI + |
| LASER* | 301 | 30 | 680 | 77 | CHI ++ |

| | | | | | |
|---|---|---|---|---|---|
| NETWORK* | 290 | 28 | 434 | 54 | CHI ++ |
| THERMODYNAMIC* | 269 | 43 | 326 | 48 | EVEN |
| DIELECTRIC* | 240 | 25 | 199 | 50 | CHI ++ |
| COMPUTER* | 229 | 24 | 336 | 41 | CHI+ |
| MAGNETIC FIELD* | 211 | 44 | 273 | 33 | IND + |
| NEUTRON* | 160 | 41 | 166 | 43 | EVEN |
| SPECTROMET* | 134 | 20 | 317 | 39 | CHI ++ |
| SENSOR OR SENSORS OR SENSING | 134 | 23 | 244 | 28 | CHI + |
| ACOUSTIC* | 102 | 13 | 119 | 17 | CHI |
| REACTION* | 1519 | 66 | 1997 | 97 | CHI+ |
| MOLECULAR | 871 | 65 | 1244 | 114 | CHI++ |
| CHEMICAL* | 923 | 46 | 1033 | 64 | CHI+ |
| DIFFRACTION | 404 | 42 | 881 | 56 | CHI+ |
| **ENVIRONMENTAL/ AGRICULTURAL SCIENCES** | | | | | |
| SOIL* | 449 | 24 | 177 | 55 | CHI ++ |
| RICE | 208 | 17 | 136 | 28 | CHI ++ |
| WHEAT | 102 | 21 | 206 | 19 | EVEN |
| ATMOSPHER* | 266 | 50 | 250 | 51 | EVEN |
| SEA | 147 | 27 | 153 | 34 | CHI |
| RIVER* | 103 | 17 | 103 | 33 | CHI++ |
| SEDIMENT* | 171 | 22 | 183 | 43 | CHI++ |
| OCEAN* | 125 | 32 | 87 | 38 | CHI |
| CLIMAT* | 122 | 21 | 109 | 52 | CHI++ |
| MAIZE | 84 | 17 | 49 | 18 | EVEN |
| **MATERIALS SCIENCES** | | | | | |
| ALLOY* | 359 | 27 | 848 | 47 | CHI ++ |
| COMPOSITES | 161 | 23 | 282 | 35 | CHI + |
| MATERIALS | 467 | 39 | 618 | 61 | CHI+ |
| METALS OR METALLIC | 343 | 49 | 363 | 52 | EVEN |
| STAINLESS STEEL* | 79 | 10 | 69 | 16 | CHI+ |
| POLYMER* | 711 | 44 | 1023 | 100 | CHI++ |
| COPOLYMER* | 157 | 18 | 286 | 35 | CHI++ |
| FERROMAGNETIC | 66 | 29 | 111 | 19 | IND+ |
| SILICON | 187 | 18 | 411 | 73 | CHI++ |
| DOPED | 226 | 43 | 321 | 28 | IND+ |
| **LIFE SCIENCES** | | | | | |
| ENZYME* | 650 | 42 | 374 | 70 | CHI ++ |
| GENE OR GENES OR GENETIC OR GENETICS | 607 | 75 | 815 | 135 | CHI ++ |
| ANTIBOD* | 292 | 32 | 247 | 76 | CHI ++ |
| CANCER | 199 | 24 | 257 | 76 | CHI ++ |
| BIOLOG* | 314 | 32 | 271 | 45 | CHI+ |
| PROTEIN* | 993 | 105 | 878 | 108 | EVEN |
| DISEASE* | 552 | 60 | 357 | 146 | CHI++ |
| BLOOD | 382 | 40 | 347 | 125 | CHI++ |
| LIVER | 253 | 29 | 223 | 52 | CHI++ |
| BACTER* | 310 | 30 | 152 | 48 | CHI+ |

Before discussing the findings, the philosophy behind Table 17 will be presented. There are a number of different metrics that could be selected for citation comparisons between the two countries. Average citations, median citations, citation distributions based on the total retrievals or a portion of the retrievals would all be candidates. However, given the nature of research, where many times only a modest fraction of projects will achieve their initial objectives, it is most important to identify those projects that generated substantial payoff. This suggests emphasis on the top layer of performing projects. This layer could be a fixed number (e.g. top ten) or a percentage of the total (e.g., top 1%). The Finland study (Kostoff et al., 2006c) used both, and the relative standings remained the same.

Thus, the citation performance of the ten most cited papers for each technology for each country was compared. Initially, both the median citations and the citations of the two highest papers were used as metrics, to obtain multiple perspectives for comparison. However, in many cases the most cited paper was an outlier, and included authors from other (more technologically advanced) countries (especially in India's case). Since the contribution of the authors from other countries to the quality of the target paper was unknown, it was believe that giving full weight for the outliers' citations to either India or China would distort the results. All the top ten papers were retained for computing the median, reflecting the reality that India or China did play some role in the outliers' quality, and the median of the top ten was the final metric employed.

Now, the findings in Table 17 will be addressed. The first column in Table 17 is the phrase, including variants in some cases. The second column is the 1998 India records retrieved for the query phrase, and the fourth column is the 1998 China records retrieved for the query phrase. The third column is the median citations of the ten most cited Indian papers, while the fifth column contains the same type of information for China papers. The sixth column is the citation 'winner' in the technical discipline examined, with the pluses (+) denoting the strength of the lead. The patterns of winners in the different broad categories are examined, and judgments are made about leadership in each of the four major categories.

The phrases (technologies) are grouped by major category. The first group is Physical Sciences. Out of twenty phrases examined, representing diverse areas of Physical Sciences, China was a clear winner in fifteen, India led in one, and four were viewed as even. Clearly, China is the leader in Physical Sciences, based on median numbers of citations.

The second group is Environmental Sciences. Out of ten phrases examined, China was the clear leader in seven, and three were considered even. Clearly, China is the leader in Environmental/ Agricultural Sciences.

The third group is Material Sciences. Out of ten phrases examined, China was the clear leader in seven, India was the clear leader in two, and one was considered even. Clearly, China is the leader in Material Sciences.

The fourth group is Life Sciences. Out of ten phrases examined, China was the clear leader in nine, and one was considered even. Clearly, China is the leader in Life Sciences.

Thus, China was the clear leader in each major category, although there were (isolated) instances where India led in a sub-technology area. This result is consistent with the Impact Factor and citation findings in the aggregate bibliometrics sections. Given the previous finding in Section 3.1.1 (Publication Trends) that China's publication fraction growth in the high Impact Factor journals is accelerating, and is out-pacing its overall publication growth, use of more recent vintage years in future citation comparisons should show even a greater dominance by China in the above type of comparison with India.

It should be re-emphasized that this comparison did not examine relative investment strategies. It focused only on technical areas that had similar magnitudes of investment. It should also be emphasized that there can be many reasons why an article receives or does not receive citations (Kostoff, 1998). These include intrinsic quality, research fundamentality (more fundamental articles receive, on average, more citations), number of researchers in discipline, and journal visibility. To identify which of these causation factors is operable, samples of articles would have to be retrieved, and each article examined in detail. Such an in-depth analysis was beyond the scope of the present study.

## 4. Taxonomies – Document Clustering

This section presents the pervasive technical themes of India's research, the relationships among those themes, and the levels of emphasis (number of research articles published) associated with each of the themes. The general approach used is to group the retrieved records into categories of similar documents, identify the central themes through phrase analysis of the records in each category, and tabulate the number of research articles associated with each category. Many approaches for grouping these records can be used. This paper uses document clustering, based on favorable results from previous text mining studies.

Document clustering is the grouping of similar documents into thematic categories. Different approaches exist (e.g., Willett, 1988; Rasmussen, 1992; Cutting, 1992; Guha, 1998; Hearst, 1998; Zamir, 1998; Karypis, 1999; Steinbach, 2000). The approach presented in this section is based on a partitional clustering algorithm (Zhao and Karypis, 2001, 2002) contained within a software package named CLUTO. Most of CLUTO's clustering algorithms treat the clustering problem as an optimization process that seeks to maximize or minimize a particular clustering criterion function defined either globally or locally over the entire clustering solution space. CLUTO uses a randomized incremental optimization algorithm that is greedy in nature, and has low computational requirements. Appendix 3 describes the partitional clustering approach in more detail.

## 4.1. Document Clustering Results

In partitional clustering, the number of clusters desired is input, and all documents in the database are included in those clusters. Clustering was done for the 1991, 2002, and 2005 documents retrieved. There were 256 clusters run (in the year 2003) for the 1991 and 2002 retrievals, and 16 clusters run (in the year 2006) for the 2005 retrieval. The clusters from the 1991 and 2002 databases are listed in detail in Appendix 4, in the order by which they appear on the hierarchical tree. The main keywords from each cluster (and the percentage of the cluster theme for which they account) are shown in parentheses after the number of records in each cluster. The keywords are arranged by their contribution to the cluster's theme, in descending order of importance. The clusters from the 2005 database are listed in detail in Appendix 5. The algorithm used to generate the 2005 clusters had the capability to ***generate metrics for each node in the taxonomy***, and these node metrics are presented in Appendix 5 as well. Finally, the algorithm used to generate the 2005 clusters had the capability to generate titles for each record in the sixteen lowest level clusters. Because of length considerations, the >14000 titles will not be included in this report.

Three levels of filtering were used to obtain the main keywords for the 1991 and 2002 taxonomies shown in Appendix 4. First, a trivial word list (e.g., of, the, on, etc) was applied to the raw data. Second, only the highest frequency words for each cluster were retained. Third, a manual filtering was performed on the thirty highest words. The themes of each cluster (in brief narrative form) follow the keywords shown. The 256 clusters for 1991 and 2002 were aggregated into a hierarchical taxonomy using a hierarchical tree generated by the CLUTO software.

To keep the body of material in the main text of this report bounded, the taxonomies for 1991 and 2002 have been placed in Appendix 4. Only the taxonomy for 2005 will be discussed here. Figure 3 contains the first four levels of the hierarchical taxonomy, with each cell in the matrix representing a technical category.

**FIGURE 3 – 2005 TAXONOMY – SCI**

| LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 |
|---|---|---|---|
| (5513) BIOMEDICAL; ENVIRON | (2626) BIOLOGICAL RESEARCH | (1458) ANIMAL EXPERIMENTS/ PLANT BIOLOGY | (807) PLANT BIOLOGY |
| | | | (651) ANIMAL EXPERIMENTS |

| | | | |
|---|---|---|---|
| | | (1168) CELL BIOLOGY/ GENETICS | |
| | (2887) CLINICAL MEDICINE; ENVIRON | (1218) HUMAN PATIENT DISEASES | |
| | | (1669) GEOLOGICAL/ MAT'L MECHANICS/ AGRICULTURAL RES | (952) SOIL/ CROP EXPERIMENTS |
| | | | (717) GEOLOGICAL RES/ MATERIAL MECHANICS |
| (8795) PHYSICAL SCIENCES/ MATHEMATIC | (3691) MATHEMATIC | (1372) ALGORITHMS/ NETWORK MODELING | |
| | | (2319) MATH ANALYSIS | (1255) CONTINUUM ANALYSIS |
| | | | (1064) MOLEC LEVEL CALC |
| | (5104) PHYSICAL SCIENCES | (2867) SURF PHYS/ CHEM | (1576) FILM PHYS |
| | | | (1291) FILM CHEM |
| | | (2237) COMPOUND CHEMISTRY | (939) CHEM BOND/ CRYS STRUCT |
| | | | (1298) REACT/ CATAL/ SYNTH |

There are four columns in Figure 3, each column representing a level of the hierarchical taxonomy. The highest level (1) is the leftmost column, and the lowest level (4) is the rightmost column. The number preceding each category heading is the number of records assigned by the algorithm to the category.

In the following discussion, the categories in Levels 1 and 4 in the table will be described. The contents of the categories in Levels 2 and 3 are self-evident from their headings and from the contents of 1 and 4. The parenthesis following each category description in Level 1 below contains two types of phrases: THEMES are the key computer-generated phrases for the category, and they determined the category theme (their numerical weightings are also included); KEYWORDS are the article author-supplied keywords for the articles in the category. The parenthesis following each category description in Level 4 contains the bibliometrics for the category, as well as the key phrases.

**Level 1** is divided into two categories: Biomedical/ Environment (5513) and Physical Sciences/ Mathematics (8795). **Biomedical/ Environment** covers biological and medical research, as well as agricultural and environmental research

(THEMES: patient 4.0%, cell 2.0%, activ 1.7%, protein 1.7%, level 1.5%, plant 1.1%, gene 1.1%, treatment 1.0%, isol 0.9%, speci 0.8%, control 0.8%, extract 0.7%, soil 0.7%, enzym 0.7%, infect 0.7%, acid 0.6%, rat 0.6%, induc 0.6%, strain 0.6%, (22.60%); KEYWORDS biochemistry & molecular biology 402; india 251; multidisciplinary sciences 189; environmental sciences 189; food science & technology 185; chemistry, medicinal 173; biotechnology & applied microbiology 172; plant sciences 171; pharmacology & pharmacy 170; plant sciences 161; geosciences, multidisciplinary 161; surgery 154; agronomy 147; growth 147; agriculture, dairy & animal science 146; immunology 141; expression 137; pharmacology & pharmacy 134; cell biology 134; biophysics 129).

**Physical Sciences/ Mathematics** covers physics, chemistry, and mathematics, with a strong emphasis on the physics and chemistry of surfaces

(THEMES: temperatur 1.8%, model 1.4%, complex 1.4%, reaction 1.2%, structur 1.1%, phase 1.1%, ion 1.0%, film 1.0%, system 1.0%, solut 0.9%, energi 0.8%, state 0.7%, compound 0.7%, acid 0.7%, electron 0.7%, paramet 0.7%, crystal 0.7%, two 0.6%, properti 0.6%, (18.70%);
KEYWORDS: chemistry, multidisciplinary 797; chemistry, organic 642; chemistry, physical 621; materials science, multidisciplinary 538; physics, multidisciplinary 488; physics, condensed matter 324; engineering, electrical & electronic 322; polymer science 309; chemistry, inorganic & nuclear 279; physics, applied 264; crystallography 261; physics, atomic, molecular & chemical 254; chemistry, analytical 236; derivatives 212; materials science, multidisciplinary 211; behavior 201; engineering, chemical 198; model 195; systems 193; physics, condensed matter 186).

**Level 4** is divided into sixteen categories. They are described in order of their listing in Figure 3, starting from the top.

- **Plant Biology (807)**

(THEMES: plant 6.9%, seed 5.1%, oil 3.4%, extract 3.2%, root 2.5%, acid 2.4%, shoot 2.4%, content 2.0%, growth 1.9%, product 1.4%, fruit 1.4%, medium 1.3%, leav 1.1%, cultur 1.1%, concentr 1.0%, soil 1.0%, germin 1.0%, isol 0.8%, supplement 0.8%, flour 0.8%;
AUTHORS: singh, r 14; kumar, s 14; singh, s 9; gupta, sk 9; bawa, as 9; singh, b 7; kumar, a 7; sridhar, kr 6; singh, m 6; singh, g 6; sharma, p 6; sharma, a 6; kumar, d 6; gupta, ak 6; ansari, sh 6; singh, sp 5; singh, n 5; singh, j 5; sharma, s 5; sharma, r 5;
JOURNALS: journal of food science and technology-mysore 116; asian journal of chemistry 34; in vitro cellular & developmental biology-plant 21; journal of essential oil research 18; journal of environmental biology 16; world journal of microbiology & biotechnology 15; indian journal of animal sciences 15; current science 14; indian journal of chemistry section b-organic chemistry including medicinal chemistry 13; indian journal of agricultural sciences 12; bioresource technology 11; process biochemistry 10; journal of the science of food and agriculture 10; food chemistry 10; scientia horticulturae 9; journal of scientific & industrial research 9; chemosphere 9; biologia plantarum 9; asian-australasian journal of animal sciences 9; journal of the indian chemical society 8;
KEYWORDS: food science & technology 154; plant sciences 71; growth 67; plant sciences 64; chemistry, multidisciplinary 51; chemistry, applied 51; environmental sciences 50; biotechnology & applied microbiology 48; food science & technology 47; agriculture, dairy & animal science 40; plants 37; agriculture, multidisciplinary 29; storage 29; quality 28; biochemistry & molecular biology 27; biotechnology & applied microbiology 26; agronomy 25; leaves 24; multidisciplinary sciences 22; cell biology 22:
COUNTRY: india 807; usa 16; south korea 13; japan 10; germany 10; france 7; england 6; hungary 5; peoples r china 4; netherlands 3; philippines 2; pakistan 2; italy 2; canada 2; bangladesh 2; australia 2; argentina 2; yemen 1; wales 1; thailand 1;
INSTITUTION: punjab agr univ 30; cent food technol res inst 25; indian inst technol 24; indian agr res inst 21; univ delhi 18; cent inst med & aromat plants 15; guru nanak dev univ 14; bhabha atom res ctr 14; aligarh muslim univ 12; tamil nadu agr univ 11; csir 11; natl dairy res inst 10; natl bot res inst 10; govind ballabh pant univ agr & technol 10; def food res lab 10; univ calcutta 9; indian vet res inst 9; indian inst chem technol 9; haryana agr univ 9; bharathiar univ 9)

This category focuses on plants and seeds, especially the extraction of oils from seeds, and has a food technology emphasis. It appears quite applied, and the main institutions are agriculture-food focused. Other Asian countries play a role equal to that of the USA, although the relatively small amount of Chinese collaboration is somewhat surprising.

- **Animal Experiments (651)**

(THEME: rat 9.9%, antioxid 3.9%, induc 3.1%, level 2.9%, dose 2.5%, glutathion 2.2%, diabet 1.9%, lipid 1.9%, liver 1.7%, extract 1.7%, activ 1.6%, anim 1.4%, administr 1.4%, enzym 1.4%, peroxid 1.3%, treatment 1.3%, bodi 1.2%, lipid.peroxid 1.1%, mice 1.0%, treat 1.0%;
AUTHORS: varalakshmi, p 13; menon, vp 10; subramanian, s 9; singh, s 9; sharma, s 9; kumar, r 9; panneerselvam, c 8; kumar, a 8; sharma, rk 7; prakash, bs 7; kumar, p 7; kulkarni, sk 7; chopra, k 7; swarup, d 6; sultana, s 6; srivastava, ak 6; rukkumani, r 6; pillai, kk 6; mythili, y 6; kumar, s 6;
JOURNALS: molecular and cellular biochemistry 36; indian journal of animal sciences 20; phytotherapy research 18; journal of ethnopharmacology 13; indian veterinary journal 13; toxicology 11; life sciences 11; journal of environmental biology 11; environmental toxicology and pharmacology 11; journal of medicinal food 10; phytomedicine 9; human & experimental toxicology 8; pharmaceutical biology 7; journal of pharmacy and pharmacology 7; clinica chimica acta 7; biological & pharmaceutical bulletin 7; toxicology mechanisms and methods 6; pharmazie 6; pharmacology biochemistry and behavior 6; pharmacological reports 6;

KEYWORDS: pharmacology & pharmacy 96; pharmacology & pharmacy 94; oxidative stress 80; chemistry, medicinal 74; glutathione 61; toxicology 60; rats 58; lipid-peroxidation 58; biochemistry & molecular biology 57; liver 50; lipid peroxidation 50; lipid-peroxidation 48; acid 42; cell biology 41; mice 41; environmental sciences 40; toxicity 37; superoxide-dismutase 36; assay 34; rat 32;
COUNTRY: india 651; usa 31; japan 7; canada 6; germany 5; peoples r china 4; kuwait 4; south korea 3; hungary 3; france 3; england 3; u arab emirates 1; taiwan 1; switzerland 1; slovakia 1; netherlands 1; malaysia 1; jordan 1; italy 1; ireland 1;
INSTITUTION: univ madras 67; annamalai univ 38; indian vet res inst 22; cent food technol res inst 17; cent drug res inst 17; panjab univ 16; bhabha atom res ctr 16; all india inst med sci 16; kasturba med coll & hosp 14; jadavpur univ 13; ind toxicol res ctr 13; univ rajasthan 12; natl dairy res inst 12; indian inst chem biol 11; univ delhi 10; punjab agr univ 10; postgrad inst med educ & res 10; maharaja sayajirao univ baroda 10; jawaharlal nehru univ 10; banaras hindu univ 10)

This category focuses on laboratory experiments for addressing diseases, especially for testing the impacts of drugs. The two main institutions, University of Madras and Annamalai University were identified on Figure 2B as having common interests in liver problems especially, and this category confirms that previous finding.

- **Cell Biology/ Genetics (1168)**

(THEME: cell 11.2%, protein 8.8%, activ 4.8%, gene 4.0%, express 3.5%, dna 1.9%, enzym 1.8%, strain 1.5%, inhibit 1.4%, sequenc 1.3%, isol 1.2%, bind 0.9%, compound 0.8%, human 0.7%, induc 0.7%, vitro 0.7%, transcript 0.6%, immun 0.5%, kda 0.5%, acid 0.5%;
AUTHORS: das, s 17; gupta, s 16; sinha, s 14; kumar, a 14; singh, s 13; singh, r 13; sharma, s 13; kumar, s 13; sharma, a 11; puri, sk 11; kumar, r 11; gupta, sk 11; tyagi, ak 10; pandey, a 10; srivastava, k 9; singh, j 9; singh, a 9; prasad, r 9; gupta, a 9; yogeeswari, p 8;
JOURNALS: biochemical and biophysical research communications 43; bioorganic & medicinal chemistry letters 32; current science 29; molecular and cellular biochemistry 24; nucleic acids research 19; journal of biological chemistry 19; world journal of microbiology & biotechnology 17; indian journal of animal sciences 16; bioorganic & medicinal chemistry 14; indian journal of biochemistry & biophysics 12; febs letters 12; indian veterinary journal 11; asian journal of chemistry 11; international journal of systematic and evolutionary microbiology 10; european journal of medicinal chemistry 10; biochemical journal 10; plant science 9; enzyme and microbial technology 9; medicinal chemistry research 8; journal of immunology 8;
KEYWORDS: biochemistry & molecular biology 284; biophysics 103; biotechnology & applied microbiology 92; expression 92; chemistry, medicinal 82; proteins 63; immunology 62; microbiology 58; cells 58; identification 55; protein 53; purification 52; chemistry, organic 50; in-vitro 48; gene 48; binding 48; cell biology 47; escherichia-coli 47; microbiology 46; sequence 44;
COUNTRY: india 1168; usa 98; germany 39; japan 27; england 22; south korea 9; france 9; italy 8; peoples r china 7; hungary 7; australia 7; switzerland 5; sweden 5; taiwan 4; spain 4; iran 4; canada 4; brazil 4; south africa 3; singapore 3;
INSTITUTION: indian inst sci 58; cent drug res inst 45; indian inst technol 42; univ delhi 39; jawaharlal nehru univ 38; ctr cellular & mol biol 37; bose inst 30; all india inst med sci 25; natl inst immunol 24; indian inst chem biol 23; indian agr res inst 23; tata inst fundamental res 22; int ctr genet engn & biotechnol 21; indian vet res inst 21; bhabha atom res ctr 21; banaras hindu univ 20; aligarh muslim univ 20; postgrad inst med educ & res 19; univ hyderabad 18; inst microbial technol 18)

This category focuses on cell biology and genetics, especially proteins and gene expression. It is one of the more fundamental research categories, as evidenced by the journals and terminology. As expected, the USA is by far the major collaborator in this fundamental research area.

- **Human Patient Diseases (1218)**

(patient 30.4%, diseas 1.9%, infect 1.7%, clinic 1.6%, women 1.3%, children 1.3%, ag 1.2%, diagnosi 1.0%, hiv 1.0%, treatment 0.9%, surgeri 0.8%, case 0.8%, therapi 0.7%, risk 0.6%, lesion 0.6%, test 0.6%, control 0.6%, mean 0.6%, ey 0.6%, complic 0.5%;
AUTHORS: kumar, a 29; srivastava, a 24; singh, r 22; kumar, r 22; kumar, s 20; sharma, a 18; gupta, ak 17; gupta, v 16; gupta, s 14; singh, s 13; singh, n 13; sharma, n 12; gupta, rk 12; saxena, r 11; purkayastha, s 11; bhattacharya, sk 11; agarwal, a 11; pandey, rm 10; mahapatra, ak 10; gupta, a 10;
JOURNALS: indian journal of medical research 34; indian veterinary journal 22; national medical journal of india 17; neurology india 14; journal of clinical neuroscience 12; journal of tropical pediatrics 11; anesthesia and analgesia 11; acta cytologica 11; surgical laparoscopy endoscopy & percutaneous techniques 10; pediatric surgery international 10; pediatric neurosurgery 10; journal of endourology 10; journal of clinical microbiology 10; annals of thoracic surgery 10; rivista di neuroradiologia 9; journal of laryngology and otology 9; international journal of dermatology 9; american journal of ophthalmology 9; tropical medicine & international health 8; medicine science and the law 8;
KEYWORDS: surgery 146; india 94; clinical neurology 82; ophthalmology 76; public, environmental & occupational health 71; occupational health 71; public, environmental & 71; medicine, general & internal 70; immunology 61; children 53; surgery 52; diagnosis 52; radiology, nuclear medicine & medical imaging 49; pediatrics 49; pediatrics 49; prevalence 47; tropical medicine 46; cardiac & cardiovascular systems 41; urology & nephrology 40; hematology 40;
COUNTRY: india 1218; usa 129; england 67; canada 23; france 20; germany 18; australia 17; italy 16; japan 14; switzerland 13; peoples r china 12; sweden 10; spain 10; netherlands 10; brazil 9; thailand 8; singapore 8; argentina 7; vietnam 6; south korea 6;

INSTITUTION: all india inst med sci 170; postgrad inst med educ & res 82; christian med coll & hosp 66; sanjay gandhi postgrad inst med sci 65; tata mem hosp 29; sree chitra tirunal inst med sci & technol 29; univ delhi 20; natl inst mental hlth & neurosci 20; king georges med univ 20; maulana azad med coll 19; lv prasad eye inst 16; kasturba med coll & hosp 16; univ coll med sci 15; indian council med res 15; safdarjang hosp 13; who 12; natl inst cholera & enter dis 12; icmr 12; univ calif san francisco 10; king edward mem hosp 10)

The focus here is clinical patient treatment, with emphasis on treatment of infections, especially HIV. Again, the USA is the major partner, with the Western democracies playing strong roles.

- **Soil/ Crop Experiments (952)**

(THEME: speci 6.5%, soil 4.7%, crop 2.6%, popul 2.4%, indian 1.7%, genet 1.7%, polymorph 1.5%, gene 1.4%, rice 1.3%, yield 1.0%, season 0.9%, area 0.9%, divers 0.8%, forest 0.8%, wheat 0.8%, plant 0.7%, trait 0.7%, pcr 0.7%, famili 0.7%, water 0.7%;
AUTHORS: kumar, s 15; kumar, a 13; bhattacharya, sk 12; singh, s 10; sharma, a 10; karunasagar, i 10; singh, r 8; sharma, r 8; sharma, s 7; kumar, n 7; sukumar, r 6; singh, rk 6; sharma, p 6; mohanty, d 6; kumar, r 6; kumar, d 6; khan, ml 6; gupta, ak 6; das, dk 6; upadhyaya, hd 5;
JOURNALS: current science 70; indian journal of agronomy 39; indian veterinary journal 35; indian journal of agricultural sciences 27; indian journal of animal sciences 24; euphytica 14; journal of the geological society of india 12; journal of environmental biology 11; environmental monitoring and assessment 9; asian-australasian journal of animal sciences 8; asian journal of chemistry 8; oriental insects 7; journal of sustainable agriculture 7; journal of human genetics 7; genetic resources and crop evolution 7; crop science 7; theoretical and applied genetics 6; revue scientifique et technique-office international des epizooties 6; plant breeding 6; journal of tropical forest science 6;
KEYWORDS: agronomy 111; india 80; multidisciplinary sciences 75; veterinary sciences 50; agriculture, dairy & animal science 45; plant sciences 45; environmental sciences 43; agriculture, multidisciplinary 42; environmental sciences 42; plant sciences 32; diversity 31; growth 30; genetics & heredity 29; yield 29; public, environmental & occupational health 26; occupational health 26; public, environmental & 26; geosciences, multidisciplinary 25; entomology 24; dna 24;
COUNTRY: india 952; usa 63; england 26; australia 25; germany 20; peoples r china 19; japan 16; france 12; south korea 8; scotland 8; netherlands 8; switzerland 7; sweden 7; spain 7; italy 7; canada 7; mexico 6; thailand 5; brazil 5; belgium 5;
INSTITUTION: indian agr res inst 32; indian inst technol 30; indian inst sci 25; int crops res inst semi arid trop 18; indian vet res inst 18; all india inst med sci 18; univ delhi 17; punjab agr univ 16; natl inst oceanog 15; jawaharlal nehru univ 15; indian stat inst 15; banaras hindu univ 14; indian council med res 13; wildlife inst india 12; bidhan chandra krishi viswavidyalaya 11; univ lucknow 10; univ calcutta 10; agharkar res inst 10; natl inst cholera & enter dis 9; univ agr sci 8)

The focus is study of soils and plant genetics to improve crop yields. It is more fundamental than the related Plant Biology category, as evidenced by the major journals, keywords, and institutions. The USA is a more dominant collaborator than in the Plant Biology category.

- **Geological Research/ Material Mechanics (717)**

(THEMES: sediment 2.2%, weld 2.1%, monsoon 1.9%, model 1.8%, crack 1.7%, water 1.6%, rock 1.3%, sea 1.3%, region 1.2%, river 1.1%, basin 1.0%, load 1.0%, surfac 1.0%, depth 0.9%, zone 0.9%, area 0.9%, steel 0.8%, stress 0.8%, fault 0.8%, aerosol 0.8%;
AUTHORS: mannan, sl 15; rao, kbs 10; singh, s 8; raj, b 8; kumar, s 8; rao, kp 7; singh, vs 6; ramesh, r 6; ghosh, s 6; ghosh, ak 6; dey, s 6; das, s 6; valsan, m 5; sinha, r 5; singh, r 5; shankar, r 5; saha, a 5; murthy, dsr 5; mondal, nc 5; latha, km 5;
JOURNALS: journal of the geological society of india 59; current science 44; transactions of the indian institute of metals 34; geophysical research letters 22; journal of earth system science 21; environmental monitoring and assessment 13; environmental geology 13; materials science and technology 12; atmospheric environment 12; journal of asian earth sciences 11; deep-sea research part ii-topical studies in oceanography 11; materials science and engineering a-structural materials properties microstructure and processing 10; international journal of remote sensing 10; journal of materials processing technology 8; indian journal of marine sciences 8; earth and planetary science letters 7; pure and applied geophysics 6; journal of geophysical research-atmospheres 6; journal of food engineering 6; geomorphology 5;
KEYWORDS: geosciences, multidisciplinary 135; materials science, multidisciplinary 65; india 55; multidisciplinary sciences 49; metallurgy & metallurgical engineering 49; environmental sciences 40; geochemistry & geophysics 33; water resources 31; engineering, civil 28; model 27; evolution 27; oceanography 26; engineering 25; metallurgy & metallurgical 25; engineering, chemical 24; behavior 24; engineering, mechanical 23; environmental sciences 23; remote sensing 21; basin 20;
COUNTRY: india 717; usa 46; germany 24; japan 18; england 15; canada 10; france 6; peoples r china 5; australia 5; italy 4; austria 4; thailand 3; south korea 3; south africa 2; singapore 2; russia 2; nepal 2; ireland 2; iran 2; finland 2;
INSTITUTION: indian inst technol 133; natl geophys res inst 45; natl inst oceanog 36; indira gandhi ctr atom res 32; indian inst sci 31; bhabha atom res ctr 28; phys res lab 20; natl inst technol 15; geol survey india 14; anna univ 14; indian inst trop meteorol 13; vikram sarabhai space ctr 12; jadavpur univ 12; isro 10; wadia inst himalayan geol 9; univ delhi 9; univ calcutta 9; natl remote sensing agcy 9; natl inst hydrol 9; struct engn res ctr 8)

This category has two dis-similar thrusts: Geological and associated environmental research, and the mechanics of materials. The common links that resulted in these thrusts appearing in the same category are stresses in solid materials and mechanical properties of materials. The next level of dis-aggregation would probably result in separation of these thrusts into different categories. The geological thrust focuses on sediments, and the materials thrust focuses on welding.

- **Algorithms/ Network Modeling (1372)**

(THEMES: algorithm 6.3%, model 5.9%, network 3.4%, system 3.3%, paper 3.2%, optim 2.2%, design 1.8%, simul 1.7%, oper 1.4%, set 1.4%, control 1.1%, time 1.1%, data 0.9%, comput 0.9%, power 0.9%, gener 0.8%, fuzzi 0.8%, paramet 0.8%, neural 0.7%, filter 0.7%;
AUTHORS: kumar, r 19; kumar, s 18; kumar, a 14; singh, s 12; chaudhuri, s 9; tiwari, mk 8; singh, r 8; singh, b 8; shah, na 8; mukherjee, s 8; mitra, s 8; rao, vr 7; gupta, v 7; gupta, p 7; gupta, a 7; ghosh, a 7; chakraborty, s 7; sinha, s 6; sarkar, p 6; roy, s 6;
JOURNALS: iete journal of research 27; microwave and optical technology letters 19; journal of scientific & industrial research 18; international journal of advanced manufacturing technology 17; sadhana-academy proceedings in engineering sciences 14; journal of materials processing technology 13; indian journal of pure & applied physics 13; iete technical review 13; defence science journal 13; physical review e 10; international journal of production research 10; iee proceedings-electric power applications 10; electric power components and systems 10; materials and manufacturing processes 9; industrial & engineering chemistry research 9; communications in statistics-theory and methods 9; mathematical and computer modelling 8; journal of mathematical analysis and applications 8; indian journal of engineering and materials sciences 8; ieee transactions on power delivery 8;
KEYWORDS: engineering, electrical & electronic 224; telecommunications 67; mathematics, applied 64; computer science, artificial intelligence 59; design 52; engineering, chemical 51; engineering, industrial 48; model 46; computer science, interdisciplinary applications 44; automation & control systems 44; systems 42; engineering, mechanical 41; optimization 40; engineering, manufacturing 39; computer science, hardware & architecture 38; mathematics, applied 38; engineering, civil 37; optics 37; computer science, 37; statistics & probability 36;
COUNTRY: india 1372; usa 124; peoples r china 33; england 24; canada 22; germany 18; france 18; south korea 15; singapore 14; japan 14; italy 13; australia 13; taiwan 8; netherlands 8; malaysia 7; sweden 6; spain 6; iran 5; saudi arabia 3; israel 3;
INSTITUTION: indian inst technol 428; indian inst sci 103; indian stat inst 64; jadavpur univ 35; natl inst technol 31; ind technol inst 23; univ delhi 22; anna univ 22; tata inst fundamental res 18; banaras hindu univ 16; univ calcutta 15; indian inst management 13; iit 13; natl chem lab 12; psg coll technol 11; osmania univ 11; cochin univ sci & technol 11; bengal engn & sci univ 11; aligarh muslim univ 11; univ hyderabad 10)

Focuses on algorithms and modeling of networks, especially communications. China plays a noticeable collaborative role in this technology-oriented category.

- **Continuum Analysis (1255)**

(THEMES: equat 5.2%, flow 3.5%, field 3.4%, wave 2.7%, veloc 1.9%, solut 1.8%, model 1.8%, numer 1.4%, fluid 1.3%, theori 1.2%, finit 1.1%, space 1.1%, dimension 1.0%, heat 0.9%, paramet 0.9%, pressur 0.8%, boundari 0.8%, magnet 0.8%, nonlinear 0.7%, function 0.7%;
AUTHORS: kumar, a 17; ghosh, s 14; chakraborty, s 13; kumar, s 11; kumar, r 11; sharma, a 8; sen, a 8; das, a 8; biswas, i 8; sunil 7; sengupta, s 7; sarkar, s 7; rahaman, f 7; kapoor, s 7; gopalakrishnan, s 7; chatterjee, a 7; sujith, ri 6; singh, r 6; singh, ak 6; rattan, vk 6;
JOURNALS: physical review e 26; physical review d 26; physics of plasmas 25; journal of high energy physics 24; international journal of heat and mass transfer 21; journal of sound and vibration 17; pramana-journal of physics 14; physical review letters 14; journal of physics a-mathematical and general 14; indian journal of pure & applied physics 14; indian journal of physics and proceedings of the indian association for the cultivation of science 14; asian journal of chemistry 14; physics of fluids 13; applied mathematics and computation 13; transactions of the indian institute of metals 12; physical review b 12; physica b-condensed matter 11; modern physics letters a 11; international journal of modern physics d 11; composite structures 11;
KEYWORDS: mechanics 122; physics, multidisciplinary 117; engineering, mechanical 97; mathematics, applied 94; physics, fluids & plasmas 89; thermodynamics 75; mathematics 64; model 59; physics, particles & fields 54; engineering, chemical 50; chemistry, physical 47; astronomy & astrophysics 46; physics, mathematical 45; mechanics 41; systems 41; flow 41; physics, condensed matter 37; chemistry, multidisciplinary 37; physics, mathematical 34; stability 33
COUNTRY: india 1255; usa 100; japan 31; germany 30; france 29; peoples r china 17; england 14; south korea 9; italy 8; canada 8; australia 8; switzerland 5; singapore 5; russia 5; kuwait 5; denmark 5; belgium 5; south africa 4; netherlands 4; iran 4;
INSTITUTION: indian inst technol 311; indian inst sci 106; tata inst fundamental res 50; jadavpur univ 43; indian stat inst 33; univ delhi 24; natl inst technol 23; harish chandra res inst 22; banaras hindu univ 21; sn bose natl ctr basic sci 20; saha inst nucl phys 20; inst math sci 19; raman res inst 17; indian assoc cultivat sci 15; panjab univ 14; kurukshetra univ 14; inst phys 14; bhabha atom res ctr 13; aligarh muslim univ 13; anna univ 12)

Focuses on equations modeling continuum fields, especially flow fields and wave equations. Emphasizes mechanics, mainly fluid but some solid as well.

- **Molecular Level Calculations (1064)**

(THEMES: energi 4.6%, state 3.4%, electron 1.9%, calcul 1.7%, bar 1.6%, laser 1.5%, densiti 1.5%, model 1.4%, decai 1.3%, gamma 1.1%, excit 1.0%, spin 1.0%, quantum 0.9%, transit 0.9%, band 0.8%, scatter 0.8%, beam 0.8%, collis 0.8%, potenti 0.8%, mode 0.7%;
AUTHORS: abe, k 64; banerjee, s 56; li, j 52; zhang, zp 50; chen, a 42; kang, jh 41; villa, s 39; matsumoto, t 39; kumar, a 37; kumar, s 36; kim, hj 35; zhang, lm 34; yamauchi, m 34; yamashita, y 34; wang, ch 34; uno, s 34; uehara, s 34; tian, xc 34; teramoto, y 34; tanaka, m 34;
JOURNALS: physical review b 50; physical review letters 49; physical review d 46; physics letters b 44; physical review c 29; journal of chemical physics 28; physical review a 27; astrophysical journal 26; astronomy & astrophysics 24; pramana-journal of physics 22; journal of physics g-nuclear and particle physics 17; indian journal of pure & applied physics 17; spectrochimica acta part a-molecular and biomolecular spectroscopy 16; physica b-condensed matter 16; journal of applied physics 16; european physical journal c 16; european physical journal a 16; physical review e 15; journal of physics b-atomic molecular and optical physics 15; international journal of quantum chemistry 15;
KEYWORDS: physics, multidisciplinary 189; physics, atomic, molecular & chemical 115; physics, condensed matter 103; physics, nuclear 87; astronomy & astrophysics 80; physics, particles & fields 75; physics, applied 66; physics, particles & fields 65; optics 62; chemistry, physical 49; model 49; physics, fluids & plasmas 35; systems 32; spectra 31; physics, mathematical 31; spectroscopy 30; optics 28; dynamics 28; spectroscopy 27; states 27;
COUNTRY: india 1064; usa 220; germany 155; russia 118; peoples r china 112; france 97; japan 95; south korea 83; taiwan 65; poland 64; england 63; switzerland 61; netherlands 52; brazil 52; italy 50; australia 48; canada 40; sweden 38; czech republic 38; austria 35;
INSTITUTION: indian inst technol 124; tata inst fundamental res 120; inst high energy phys 85; panjab univ 76; bhabha atom res ctr 75; korea univ 67; univ sci & technol china 63; princeton univ 63; indian inst sci 61; inst theoret & expt phys 57; univ tokyo 56; univ tsukuba 50; tokyo inst technol 49; brookhaven natl lab 49; chinese acad sci 48; saha inst nucl phys 47; yonsei univ 45; univ delhi 45; seoul natl univ 45; natl cent univ 45)

Physics-oriented category. Focuses on energy states, and calculations at the atomic and molecular level. Strong levels of co-authorship. Basic research, published in more well-known physics journals. Large international high energy physics experiments involved.

- **Film Physics (1576)**

(THEMES: film 8.6%, temperatur 5.6%, phase 2.2%, crystal 2.1%, alloi 1.9%, composit 1.9%, glass 1.8%, magnet 1.6%, deposit 1.5%, rai 1.3%, sampl 1.3%, conduct 1.2%, ion 1.1%, dope 1.0%, structur 1.0%, properti 1.0%, powder 1.0%, diffract 0.9%, size 0.9%, (38.72%);
AUTHORS: kumar, a 26; malik, sk 25; avasthi, dk 22; kumar, s 20; tyagi, ak 17; rao, jl 15; nigam, ak 15; chaudhuri, s 15; bahadur, d 15; singh, s 14; ravi, v 14; kumar, r 14; gupta, a 14; rao, cnr 13; ghosh, a 12; das, s 12; singh, f 11; kumar, v 11; ghosh, s 11; choudhary, rnp 11;
JOURNALS: journal of applied physics 76; bulletin of materials science 52; materials letters 46; physica b-condensed matter 42; pramana-journal of physics 39; physical review b 39; indian journal of physics and proceedings of the indian association for the cultivation of science 39; materials chemistry and physics 34; solid state communications 31; journal of crystal growth 27; indian journal of pure & applied physics 27; materials science and engineering b-solid state materials for advanced technology 26; applied physics letters 26; crystal research and technology 22; materials research bulletin 21; journal of the american ceramic society 21; journal of nanoscience and nanotechnology 21; journal of magnetism and magnetic materials 21; journal of non-crystalline solids 20; materials science and engineering a-structural materials properties microstructure and processing 19;
KEYWORDS: materials science, multidisciplinary 419; physics, condensed matter 168; physics, applied 156; physics, condensed matter 133; physics, multidisciplinary 120; chemistry, physical 120; physics, applied 117; materials science, multidisciplinary 107; films 81; temperature 79; behavior 73; materials science, ceramics 72; growth 67; engineering 66; metallurgy & metallurgical 66; chemistry, multidisciplinary 65; thin-films 65; crystallography 63; microstructure 60; system 59;
COUNTRY: india 1576; usa 71; japan 71; germany 62; south korea 37; france 34; taiwan 20; england 18; peoples r china 17; italy 11; spain 10; switzerland 6; russia 6; mexico 6; malaysia 6; brazil 6; israel 5; australia 5; singapore 4; poland 4;
INSTITUTION: indian inst technol 254; indian inst sci 97; bhabha atom res ctr 81; tata inst fundamental res 64; indian assoc cultivat sci 57; natl phys lab 46; natl chem lab 46; ctr nucl sci 36; cent glass & ceram res inst 36; banaras hindu univ 36; sri venkateswara univ 33; univ delhi 32; indira gandhi ctr atom res 30; anna univ 29; cent electrochem res inst 27; shivaji univ 24; chinese acad sci 23; jawaharlal nehru ctr adv sci res 22; inst phys 22; ctr adv technol 22

***CATEGORY HAS TWO MAIN THRUSTS: SMALL-SCALE FILM MEASUREMENTS AND FILM DEPOSITION AND GROWTH***

**Small-Scale Film Measurements (1166 Records)**

THEMES: temperatur 6.6%, crystal 3.6%, phase 3.3%, alloi 2.7%, magnet 2.5%, composit 2.4%, glass 2.1%, sampl 1.7%, powder 1.6%, rai 1.4%, transit 1.3%, dielectr 1.2%, particl 1.2%, conduct 1.1%, diffract 1.1%, dope 1.1%, structur 1.1%, properti 1.0%, size 0.9%, ion 0.9%;
AUTHORS: malik, sk 22; tyagi, ak 15; rao, jl 15; nigam, ak 15; bahadur, d 15; ravi, v 14; kumar, s 14; chaudhuri, s 13; kumar, a 12; ghosh, a 12; rao, cnr 11; gupta, a 11; choudhary, rnp 11; nirmala, r 10; gopal, no 10; chakradhar, rps 10; singh, s 9; singh, k 9; sebastian, mt 9; ramasamy, p 9;
JOURNALS: journal of applied physics 54; bulletin of materials science 42; physical review b 34; materials letters 34; physica b-condensed matter 31; indian journal of physics and proceedings of the indian association for the cultivation of science 29; pramana-journal of physics 28; solid state communications 27; materials chemistry and physics 23; journal of crystal growth 22; indian journal of pure & applied physics 22; materials science and engineering b-solid state materials for advanced technology 21; journal of the american ceramic society 20; journal of magnetism and magnetic materials 20; materials science and engineering a-structural materials properties microstructure and processing 19; crystal research and technology 19; journal of alloys and compounds 18; journal of materials science 17; applied physics letters 17; spectrochimica acta part a-molecular and biomolecular spectroscopy 16;
KEYWORDS: materials science, multidisciplinary 307; physics, condensed matter 136; physics, applied 114; physics, condensed matter 93; physics, multidisciplinary 92; chemistry, physical 88; materials science, multidisciplinary 87; temperature 65; materials science, ceramics 64; physics, applied 63; behavior 57; engineering 55; crystallography 55; metallurgy & metallurgical 55; films 55; system 52; chemistry, multidisciplinary 50; microstructure 45; x-ray diffraction 41; nanoparticles 38;
COUNTRY: india 1166; japan 62; usa 54; germany 52; france 27; south korea 18; england 15; peoples r china 13; taiwan 12; spain 10; italy 7; russia 6; brazil 6; malaysia 5; switzerland 4; canada 4; singapore 3; poland 3; greece 3; australia 3;
INSTITUTION: indian inst technol 204; indian inst sci 78; bhabha atom res ctr 67; tata inst fundamental res 55; indian assoc cultivat sci 45; natl chem lab 43; banaras hindu univ 30; cent glass & ceram res inst 27; anna univ 27; sri venkateswara univ 26; natl phys lab 23; indira gandhi ctr atom res 22; def met res lab 20; chinese acad sci 19; natl met lab 18; csir 18; tohoku univ 17; natl inst technol 17; jawaharlal nehru ctr adv sci res 17; osmania univ 16;

**Film Deposition and Growth (410)**

THEMES: film 43.4%, deposit 7.1%, thin.film 3.6%, thin 3.3%, substrat 2.1%, coat 2.0%, temperatur 1.2%, optic 0.9%, anneal 0.7%, thick 0.6%, ion 0.6%, surfac 0.5%, conduct 0.5%, irradi 0.5%, film.deposit 0.5%, resist 0.5%, electr 0.4%, glass 0.4%, rai 0.4%, properti 0.4%;
AUTHORS: avasthi, dk 18; kumar, a 14; agnihotry, sa 10; singh, f 9; mangalaraj, d 9; lokhande, cd 9; verma, a 7; tripathi, sk 7; narayandass, sk 7; menon, cs 7; thakur, a 6; saini, gss 6; saikia, d 6; kumar, s 6; goyal, n 6; bakhshi, ak 6; yakhmi, jv 5; vijayakumar, kp 5; singh, s 5; sharma, v 5;
JOURNALS: journal of applied physics 22; applied surface science 17; thin solid films 15; surface engineering 13; materials letters 12; sensors and actuators b-chemical 11; pramana-journal of physics 11; physica b-condensed matter 11; materials chemistry and physics 11; journal of optoelectronics and advanced materials 10; indian journal of physics and proceedings of the indian association for the cultivation of science 10; bulletin of materials science 10; solar energy materials and solar cells 9; applied physics letters 9; nuclear instruments & methods in physics research section b-beam interactions with materials and atoms 8; surface & coatings technology 6; journal of nanoscience and nanotechnology 6; physical review b 5; materials science and engineering b-solid state materials for advanced technology 5; materials research bulletin 5;
KEYWORDS: materials science, multidisciplinary 112; physics, applied 54; physics, applied 42; physics, condensed matter 40; physics, 35; thin-films 33; physics, condensed matter 32; chemistry, physical 32; growth 32; physics, multidisciplinary 28; materials science, coatings & films 28; films 26; engineering, electrical & electronic 23; thin films 22; deposition 22; materials science, multidisciplinary 20; electrochemistry 20; thin-films 18; condensed matter 18; optical-properties 18;
COUNTRY: india 410; south korea 19; usa 17; germany 10; japan 9; taiwan 8; france 7; peoples r china 4; mexico 4; italy 4; israel 3; ireland 3; england 3; switzerland 2; netherlands 2; australia 2; south africa 1; slovakia 1; singapore 1; portugal 1;
INSTITUTION: indian inst technol 50; natl phys lab 23; ctr nucl sci 22; univ delhi 21; indian inst sci 19; cent electrochem res inst 18; shivaji univ 15; bhabha atom res ctr 14; inst phys 12; indian assoc cultivat sci 12; cochin univ sci & technol 11; bharathiar univ 10; tata inst fundamental res 9; cent glass & ceram res inst 9; alagappa univ 9; solid state phys lab 8; saha inst nucl phys 8; indira gandhi ctr atom res 8; univ poona 7; tezpur univ 7)

Focuses on surface physics/ films. Main thrusts are small-scale film measurements and film deposition and growth. In both thrusts, USA is eclipsed as dominant collaborator by an Asian country.

- **Film Chemistry (1291)**

(THEMES: adsorpt 3.0%, concentr 2.7%, polym 2.6%, ion 2.6%, dye 2.2%, solut 1.9%, blend 1.8%, surfact 1.7%, water 1.6%, acid 1.5%, membran 1.3%, micel 1.1%, aqueou 1.0%, composit 1.0%, surfac 0.9%, temperatur 0.9%, resin 0.9%, properti 0.7%, electrod 0.7%, (30.82%);
AUTHORS: kumar, s 22; singh, b 17; pal, a 17; mukherjee, t 15; thomas, s 14; basu, s 14; gupta, vk 13; nath, s 11; ghosh, sk 11; bakshi, ms 11; sridhar, s 10; sastry, m 10; pal, t 10; moulik, sp 10; kundu, s 10; kumar, r 10; kumar, a 10; singh, ak 9; panigrahi, s 9; aminabhavi, tm 9;
JOURNALS: asian journal of chemistry 65; journal of applied polymer science 49; journal of polymer materials 42; journal of colloid and interface science 38; journal of the indian chemical society 32; journal of physical chemistry b 29; indian journal of chemical technology 26; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 25; colloids and surfaces a-physicochemical and engineering aspects 18; journal of hazardous materials 17; polymer international 16; journal of

reinforced plastics and composites 16; journal of pharmaceutical and biomedical analysis 16; chemical physics letters 16; separation and purification technology 15; journal of macromolecular science-pure and applied chemistry 15; talanta 14; langmuir 14; polymer 13; european polymer journal 12;
KEYWORDS: polymer science 206; chemistry, physical 181; chemistry, multidisciplinary 181; chemistry, analytical 126; water 81; adsorption 79; engineering, chemical 73; engineering, chemical 70; chemistry, applied 70; kinetics 67; behavior 54; polymer science 53; adsorption 45; sorption 45; materials science, multidisciplinary 43; environmental sciences 41; acid 41; polymers 37; removal 36; physics, atomic, molecular & chemical 35;
COUNTRY: india 1291; usa 28; germany 21; japan 14; south korea 13; canada 10; france 9; england 6; australia 6; peoples r china 5; italy 5; portugal 3; iran 3; sweden 2; new zealand 2; netherlands 2; israel 2; belgium 2; taiwan 1; switzerland 1;
INSTITUTION: indian inst technol 177; bhabha atom res ctr 54; indian inst sci 44; anna univ 43; indian inst chem technol 35; natl chem lab 34; jadavpur univ 34; indian assoc cultivat sci 25; csir 25; aligarh muslim univ 24; guru nanak dev univ 23; cent electrochem res inst 20; univ delhi 19; univ bombay 18; reg res lab 17; mahatma gandhi univ 17; cent leather res inst 17; cent food technol res inst 17; banaras hindu univ 14; andhra univ 14

***CATEGORY HAS TWO MAIN THRUSTS: POLYMER CHEMISTRY/ PROPERTIES AND SURFACE WET CHEMISTRY***

**Polymer Chemistry/ Properties (479 Records)**

THEMES: polym 8.8%, blend 7.6%, membran 2.8%, composit 2.7%, resin 2.6%, copolym 2.5%, poli 2.0%, properti 1.9%, thermal 1.4%, crosslink 1.3%, graft 1.3%, strength 1.0%, polymer 0.9%, mechan 0.8%, temperatur 0.8%, cure 0.8%, acid 0.8%, stabil 0.8%, scan 0.7%, weight 0.7%;
AUTHORS: thomas, s 14; sridhar, s 10; aminabhavi, tm 9; singh, b 8; siddaramaiah 8; kumar, s 8; kumar, r 8; smitha, b 7; sekhon, ss 7; kapadi, ur 7; hundiwale, dg 7; das, ck 7; bhowmick, ak 7; kumar, a 6; asthana, sn 6; ashraf, sm 6; raju, km 5; rai, sk 5; mohan, ym 5; bajpai, ak 5;
JOURNALS: journal of applied polymer science 47; journal of polymer materials 41; journal of reinforced plastics and composites 16; polymer international 15; journal of macromolecular science-pure and applied chemistry 14; polymer 13; polymer-plastics technology and engineering 11; journal of materials science 9; indian journal of physics and proceedings of the indian association for the cultivation of science 9; european polymer journal 9; journal of the indian chemical society 7; macromolecules 6; journal of scientific & industrial research 6; journal of polymer science part b-polymer physics 6; journal of membrane science 6; polymers & polymer composites 5; journal of polymer science part a-polymer chemistry 5; asian journal of chemistry 5; radiation measurements 4; pigment & resin technology 4;
KEYWORDS: polymer science 234; behavior 34; engineering, chemical 31; polymers 31; chemistry, multidisciplinary 29; composites 28; materials science, composites 27; morphology 25; materials science, multidisciplinary 23; composites 21; chemistry, physical 21; chemistry, analytical 19; water 18; blends 18; kinetics 17; viscosity 16; temperature 16; rubber 15; mechanical-properties 14
COUNTRY: india 479; usa 14; south korea 7; germany 7; france 5; peoples r china 4; england 3; australia 3; japan 2; canada 2; taiwan 1; singapore 1; portugal 1; north ireland 1; new zealand 1; netherlands 1; italy 1; israel 1; belgium 1;
INSTITUTION: indian inst technol 57; indian inst sci 25; indian inst chem technol 23; anna univ 20; natl chem lab 19; mahatma gandhi univ 17; cent food technol res inst 12; univ mysore 11; sri krishnadevaraya univ 10; jadavpur univ 10; n maharashtra univ 9; karnatak univ 9; guru nanak dev univ 9; indian assoc cultivat sci 8; cent leather res inst 8; univ bombay 7; jamia millia islamia 7; himachal pradesh univ 7; cent salt & marine chem res inst 7; bhabha atom res ctr 7

**Surface Wet Chemistry (812 Records)**

THEMES: adsorpt 5.8%, dye 4.0%, ion 4.0%, concentr 3.5%, surfact 3.3%, solut 2.2%, micel 2.1%, water 1.6%, aqueou 1.5%, electrod 1.2%, adsorb 1.2%, acid 1.2%, fluoresc 1.2%, remov 1.1%, surfac 1.0%, sodium 0.9%, cation 0.8%, nanoparticl 0.7%, carbon 0.7%, micellar 0.7%;
AUTHORS: pal, a 16; mukherjee, t 14; kumar, s 14; gupta, vk 13; basu, s 13; nath, s 11; ghosh, sk 11; bakshi, ms 11; sastry, m 10; pal, t 10; kundu, s 10; singh, b 9; singh, ak 9; panigrahi, s 9; moulik, sp 9; palanivelu, k 8; pal, h 8; kumbhakar, m 8; sankar, dg 7; roy, s 7;
JOURNALS: asian journal of chemistry 60; journal of colloid and interface science 34; journal of physical chemistry b 27; journal of the indian chemical society 25; indian journal of chemical technology 24; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 21; colloids and surfaces a-physicochemical and engineering aspects 18; journal of pharmaceutical and biomedical analysis 15; journal of hazardous materials 15; chemical physics letters 15; langmuir 14; separation and purification technology 12; bulletin of electrochemistry 12; talanta 11; dyes and pigments 11; spectrochimica acta part a-molecular and biomolecular spectroscopy 10; water research 9; colloid and polymer science 9; sensors and actuators b-chemical 8; journal of chemical sciences 8;
KEYWORDS: chemistry, physical 160; chemistry, multidisciplinary 152; chemistry, analytical 107; adsorption 76; water 63; engineering, chemical 63; chemistry, applied 56; kinetics 50; adsorption 44; engineering, chemical 39; environmental sciences 37; sorption 35; removal 34; ions 31; physics, atomic, molecular & chemical 29; fluorescence 29; electrochemistry 28; acid 27; oxidation 25; spectroscopy 24
COUNTRY: india 812; usa 14; germany 14; japan 12; canada 8; south korea 6; italy 4; france 4; iran 3; england 3; australia 3; sweden 2; portugal 2; switzerland 1; spain 1; saudi arabia 1; romania 1; peoples r china 1; pakistan 1; new zealand 1;
INSTITUTION: indian inst technol 120; bhabha atom res ctr 47; jadavpur univ 24; anna univ 23; aligarh muslim univ 23; indian inst sci 19; csir 19; cent electrochem res inst 18; univ delhi 17; indian assoc cultivat sci 17; natl chem lab 15; guru nanak dev univ 14; saha inst nucl phys 13; reg res lab 13; andhra univ 13; indian inst chem technol 12; banaras hindu univ 12; univ bombay 11; univ madras 9; s gujarat univ 9)

Focuses on film chemistry, mainly polymer chemistry/ properties and surface wet chemistry. Polymer work appears quite applied.

- **Chemical Bonds/ Crystal Structures (939)**

(THEMES: complex 16.7%, dot 7.3%, center 6.4%, ligand 3.9%, bond 3.6%, hydrogen 2.3%, hydrogen.bond 1.9%, structur 1.9%, crystal 1.9%, molecul 1.8%, ring 1.5%, conform 1.1%, interact 1.0%, compound 1.0%, titl 1.0%, iii 0.9%, angstrom 0.9%, titl.compound 0.7%, form 0.7%, (57.09%);
AUTHORS: ravikumar, k 42; velmurugan, d 27; selvanayagam, s 20; sharma, r 16; raghunathan, r 16; sridhar, b 15; sharma, s 15; nethaji, m 15; fun, hk 15; chandra, s 15; rajaram, rk 13; natarajan, s 13; yathirajan, hs 12; sharma, rp 12; bala, r 12; singh, tp 11; kumar, r 10; drew, mgb 10; srinivasan, pc 9; singh, n 9;
JOURNALS: acta crystallographica section e-structure reports online 126; asian journal of chemistry 56; journal of the indian chemical society 48; spectrochimica acta part a-molecular and biomolecular spectroscopy 42; transition metal chemistry 39; inorganic chemistry 27; polyhedron 23; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 21; inorganica chimica acta 18; european journal of inorganic chemistry 16; journal of organometallic chemistry 15; journal of physical chemistry a 14; journal of molecular structure 14; journal of coordination chemistry 14; journal of chemical crystallography 14; synthesis and reactivity in inorganic metal-organic and nano-metal chemistry 13; chemical communications 13; inorganic chemistry communications 12; acta crystallographica section c-crystal structure communications 12; journal of molecular structure-theochem 10;
KEYWORDS: chemistry, multidisciplinary 210; chemistry, inorganic & nuclear 199; crystallography 183; chemistry, physical 92; crystal-structure 72; complexes 67; ligands 62; crystal-structure 60; spectroscopy 55; derivatives 53; chemistry 51; complexes 49; biochemistry & molecular biology 46; chemistry, organic 38; acid 37; spectroscopy 36; crystallography 36; crystal structure 36; cobalt(ii) 34; nickel(ii) 33;
COUNTRY: india 939; usa 48; germany 32; england 30; spain 22; peoples r china 15; malaysia 15; taiwan 14; italy 12; france 11; japan 10; scotland 9; switzerland 8; poland 8; czech republic 7; australia 5; netherlands 4; canada 4; norway 3; fiji 3;
INSTITUTION: indian inst technol 88; indian inst sci 77; indian inst chem technol 56; univ madras 44; univ hyderabad 40; bharathidasan univ 31; jadavpur univ 30; indian assoc cultivat sci 28; bhabha atom res ctr 28; madurai kamaraj univ 26; univ delhi 24; univ mysore 21; univ burdwan 21; univ rajasthan 19; univ calcutta 17; univ poona 15; natl chem lab 15; aligarh muslim univ 15; univ sains malaysia 14; univ barcelona 13

CATEGORY HAS TWO MAIN THRUSTS: LIGAND-METAL COMPLEX SYNTHESIS AND COMPOUND HYDROGEN BONDS

**LIGAND-METAL COMPLEX SYNTHESIS (460 Records)**

THEMES: complex 38.6%, ligand 9.2%, iii 2.1%, metal 1.4%, spectral 1.0%, nmr 0.9%, copper 0.8%, synthes 0.8%, coordin 0.7%, geometri 0.7%, element 0.7%, h2o 0.7%, electron 0.6%, magnet 0.6%, bind 0.5%, ion 0.5%, schiff.base 0.5%, schiff 0.5%, clo4 0.5%, spectra 0.4%;
AUTHORS: chandra, s 15; nethaji, m 9; gupta, lk 9; sharma, s 8; patil, sa 7; kumar, a 7; gudasi, kb 7; vadavi, rs 6; sinha, c 6; shenoy, rv 6; sarkar, s 6; ramesh, r 6; raman, n 6; patil, ms 6; kollipara, mr 6; drew, mgb 6; bhattacharya, s 6; viswanathan, m 5; singh, n 5; singh, ks 5;
JOURNALS: asian journal of chemistry 54; journal of the indian chemical society 46; transition metal chemistry 35; spectrochimica acta part a-molecular and biomolecular spectroscopy 29; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 19; polyhedron 18; inorganic chemistry 18; journal of organometallic chemistry 13; european journal of inorganic chemistry 13; synthesis and reactivity in inorganic metal-organic and nano-metal chemistry 12; inorganica chimica acta 12; journal of coordination chemistry 9; polish journal of chemistry 8; inorganic chemistry communications 7; main group metal chemistry 5; dalton transactions 5; applied organometallic chemistry 5; journal of thermal analysis and calorimetry 4; journal of scientific & industrial research 4; journal of molecular structure 4;
KEYWORDS: chemistry, multidisciplinary 163; chemistry, inorganic & nuclear 149; ligands 48; complexes 44; complexes 39; crystal-structure 37; spectroscopy 33; nickel(ii) 33; cobalt(ii) 33; metal-complexes 29; derivatives 29; chemistry 29; crystal-structure 28; chemistry, physical 26; coordination 26; copper(ii) 25; chemistry, organic 25; synthesis 23; crystallography 22; cu(ii) 19;
COUNTRY: india 460; usa 22; spain 16; england 14; taiwan 12; germany 10; japan 8; peoples r china 6; czech republic 6; italy 5; switzerland 3; scotland 3; france 3; fiji 3; canada 3; australia 3; poland 2; malaysia 2; ethiopia 1; brazil 1;
INSTITUTION: indian inst technol 35; univ delhi 20; jadavpur univ 19; univ rajasthan 18; univ burdwan 17; indian inst sci 16; indian assoc cultivat sci 13; bhabha atom res ctr 12; aligarh muslim univ 12; univ hyderabad 10; univ barcelona 10; bharathidasan univ 10; univ calcutta 9; ne hill univ 9; karnatak univ 9; univ allahabad 8; banaras hindu univ 8; univ poona 7; univ kalyani 7; univ reading 6

**COMPOUND HYDROGEN BONDS (479 Records)**

THEMES: dot 15.6%, center 12.5%, bond 6.5%, hydrogen 4.8%, hydrogen.bond 4.1%, molecul 3.2%, crystal 3.0%, ring 3.0%, structur 2.5%, conform 2.4%, titl 2.3%, angstrom 1.8%, titl.compound 1.8%, compound 1.5%, interact 1.3%, crystal.structur 0.9%, form 0.8%, intermolecular 0.7%, atom 0.7%, dimer 0.6%
AUTHORS: ravikumar, k 42; velmurugan, d 27; selvanayagam, s 20; sridhar, b 15; raghunathan, r 15; rajaram, rk 13; natarajan, s 13; fun, hk 13; yathirajan, hs 12; singh, tp 11; sharma, r 11; srinivasan, pc 9; sharma, rp 9; ramakrishnan, v 9; bala, r 9; sridhar, ma 8; prasad, js 8; dey, s 8; desiraju, gr 8; athimoolam, s 8;
JOURNALS: acta crystallographica section e-structure reports online 125; spectrochimica acta part a-molecular and biomolecular spectroscopy 13; journal of chemical crystallography 13; acta crystallographica section c-crystal structure communications 12; journal of physical chemistry a 11; journal of molecular structure 10; journal of molecular structure-theochem 9; inorganic chemistry 9; crystengcomm 9; crystal growth & design 9; chemical communications 9; journal of physical chemistry b 8; journal of photochemistry

and photobiology a-chemistry 7; acta crystallographica section d-biological crystallography 7; inorganica chimica acta 6; chemical physics letters 6; biopolymers 6; tetrahedron 5; structural chemistry 5; polyhedron 5;
KEYWORDS: crystallography 177; chemistry, physical 66; chemistry, inorganic & nuclear 50; chemistry, multidisciplinary 47; biochemistry & molecular biology 39; crystal-structure 35; crystal-structure 32; spectroscopy 25; derivatives 24; complexes 23; acid 23; spectroscopy 22; chemistry 22; biophysics 22; crystal structure 21; crystal-structures 20; chemistry, organic 19; physics, atomic, molecular & chemical 16; binding 16; hydrogen bonding 15;
COUNTRY: india 479; usa 26; germany 22; england 16; malaysia 13; peoples r china 9; france 8; italy 7; spain 6; scotland 6; poland 6; switzerland 5; netherlands 4; norway 3; denmark 3; belgium 3; taiwan 2; sweden 2; singapore 2; japan 2;
INSTITUTION: indian inst sci 61; indian inst technol 53; indian inst chem technol 53; univ madras 40; univ hyderabad 30; madurai kamaraj univ 26; univ mysore 21; bharathidasan univ 21; bhabha atom res ctr 16; indian assoc cultivat sci 15; univ sains malaysia 13; anna univ 13; all india inst med sci 12; jadavpur univ 11; jawaharlal nehru ctr adv sci res 10; univ jammu 9; natl chem lab 9; univ poona 8; univ calcutta 8; punjabi univ 8)

Focuses on chemical bonds and crystal structures, emphasizing ligand-metal complex synthesis and compound hydrogen bonds. Ligand-metal synthesis emphasizes domestic journals, and is relatively more applied than hydrogen bond work.

- **Reactions/ Catalysis/ Synthesis (1298)**

(THEMES: reaction 11.9%, catalyst 4.4%, synthesi 4.0%, yield 3.7%, acid 3.5%, compound 3.2%, substitut 2.2%, oxid 1.7%, synthes 1.4%, aryl 1.0%, methyl 1.0%, deriv 1.0%, condens 1.0%, activ 1.0%, aldehyd 0.9%, afford 0.9%, product 0.9%, beta 0.7%, step 0.7%, ester 0.7%;
AUTHORS: yadav, js 28; kumar, a 17; reddy, pn 15; yadav, gd 14; rajitha, b 13; kumar, s 13; kumar, p 13; singh, b 12; kumar, r 12; srikrishna, a 11; reddy, yt 11; reddy, bvs 11; singh, ak 10; nair, v 10; kantam, ml 10; singh, p 9; narayana, b 9; kumar, bs 9; halligudi, sb 9; sharma, a 8;
JOURNALS: tetrahedron letters 144; indian journal of chemistry section b-organic chemistry including medicinal chemistry 113; asian journal of chemistry 78; synthetic communications 54; indian journal of heterocyclic chemistry 53; journal of the indian chemical society 50; journal of molecular catalysis a-chemical 45; journal of chemical research-s 36; synlett 34; tetrahedron 31; synthesis-stuttgart 29; journal of organic chemistry 28; journal of heterocyclic chemistry 25; tetrahedron-asymmetry 20; oxidation communications 19; applied catalysis a-general 18; heterocyclic communications 17; organic letters 16; letters in organic chemistry 16; journal of applied polymer science 14;
KEYWORDS: chemistry, organic 593; chemistry, multidisciplinary 267; derivatives 131; chemistry, physical 121; oxidation 75; chemistry, organic 68; acid 61; chemistry, inorganic & nuclear 60; synthesis 55; alcohols 54; kinetics 50; chemistry, applied 47; derivatives 46; chemistry 46; aldehydes 42; mechanism 40; chemistry, physical 40; polymer science 39; chemistry, medicinal 39; complexes 38;
COUNTRY: india 1298; usa 25; germany 16; japan 13; france 12; england 8; spain 5; denmark 5; taiwan 4; south korea 4; peoples r china 4; italy 4; netherlands 3; switzerland 2; south africa 2; hungary 2; bangladesh 2; austria 2; wales 1; sweden 1;
INSTITUTION: indian inst chem technol 113; indian inst technol 106; natl chem lab 86; indian inst sci 42; cent drug res inst 34; univ madras 29; bangalore univ 26; csir 23; natl inst technol 21; univ bombay 20; jadavpur univ 20; univ delhi 19; univ mysore 17; karnatak univ 17; mangalore univ 16; andhra univ 16; univ allahabad 15; reg res lab 15; guru nanak dev univ 15; univ rajasthan 14)

Applied organic chemistry category, emphasizing chemical reactions, catalysis, and synthesis.

Finally, the relation between the research expenditures of Table 2 and the sixteen categories of research output articles above is examined. There were four main categories of expenditures from Table 2 (category/ % of budget):

- Natural Sciences (21%)
- Engineering & Technology (50%)
- Medical Sciences (8%)
- Agricultural Sciences (20%)

The sixteen research output categories can be classified under the four research expenditure categories in the following very approximate manner (category/ # records):

- Natural Sciences (21%)
    - Continuum Analysis (1255)
    - Molecular Level Calculations (1064)
    - Film Physics (1576)
    - Film Chemistry (1291)
    - Chemical Bonds/ Crystal Structures (939)
    - Reactions/ Catalysis/ Synthesis (1298)

- Engineering & Technology (50%)
    - Geological Research/ Material Mechanics (717)
    - Algorithms/ Network Modeling (1372)

- Medical Sciences (8%)
    - Animal Experiments (651)
    - Cell Biology/ Genetics (1168)
    - Human Patient Diseases (1218)

- Agricultural Sciences (20%)
    - Plant Biology (807)
    - Soil/ Crop Experiments (952)

The relation between the percentage of expenditures assigned to the four funding categories and the percentage of articles assigned to these same categories is as follows (category name/ expenditure percent/ article percent):

- Natural Sciences (21%/ 52%)
- Engineering & Technology (50%/ 15%)
- Medical Sciences (8%/ 21%)
- Agricultural Sciences (20%/ 12%)

While different assignments of the sixteen output categories to the four expenditure categories are certainly possible (for example, one could argue that the continuum analysis category of fluid and solid mechanics is really an engineering category), nevertheless, the above imbalances are probably real. The main imbalance appears to be between the Natural Sciences and the Engineering and Technology expenditure categories. The articles in the Natural Sciences categories covered fields such as physics, chemistry, and mathematics. However, there was much applied work in each of these component fields. If the more applied research in these component fields were viewed as Technology, and transferred from the Natural Sciences category to the Engineering and Technology category, the major imbalance would be redressed substantially. In order to make this determination of basic/ applied fractions, a much larger number of research output categories (clusters) with much more narrowly defined themes would have to be generated. The present level of research output category resolution (16 categories) does not allow this breakdown.

The primary objective of this study was to examine the structure of India's research at the higher levels. Accordingly, the sixteen categories for the 2005 database are at a relatively coarse level of resolution. In particular, much more accurate results relating research outputs to research expenditures (above) would be possible with much more well-defined categories. An assessment oriented toward more specific technology analyses would require narrower more well-defined clusters, translating into using a larger number of clusters. The present technique is fully translatable into analyzing hundreds or thousands of clusters.

# DISCUSSION AND CONCLUSIONS

## D1. Purpose and Approach

The purposes of this study are to:

- Identify the S&T core competencies of India
- Compare representative competencies with those of at least one other country
- Generate a process that could be used efficiently and rapidly to assess the S&T core competencies in other countries of interest, including comparison with a variety of countries

Two types of results are presented, bibliometrics and taxonomies. Bibliometrics provide an indication of the technical infrastructure (prolific authors, journals, institutions, citations), while taxonomies provide an indication of major technology thrusts and their relationships. For the present study, the Science Citation Index/ Social Science Citation Index (SCI/ SSCI) database was used.

## D2. Results

### D2.1. Overall India Bibliometrics

#### D2.1.1. Aggregate Publication Trends

The first metric is number of articles as a function of time. All research articles in the SCI/ SSCI having at least one author with an India address were retrieved for every fifth year from 1980-2005. The same was done for China.

***The differences between China and India are dramatic! From 1980-2005, China's research article output increased by two orders of magnitude (692 articles-72310 articles), while India's output increased by 2.5 (10606 articles-25367 articles), a factor of forty difference!***

Some strong caveats are in order at this point. Growth in SCI/ SSCI articles is a function of:

- increased research sponsorship

- increased productivity in a country
- increase in the number of journals accessed by the SCI/ SSCI

Of the top 21 journals in which Indian authors publish, the median initial journal access date (the initial date of SCI/ SSCI publication of articles from that journal) in the SCI/ SSCI was ***1970***. Of the top 20 journals in which Chinese authors publish, the median initial publication date in the SCI/ SSCI was ***1995*** (with the more recently accessed journals having relatively low Impact Factors [measures of a journal's ability to attract citations]). ***Thus, at least some of the excess growth of China's research article output relative to that of India must have come from additional journals being accessed by the SCI/ SSCI, rather than purely increased productivity or increased research sponsorship.***

D2.1.2. Publication Trends in High Impact Factor Journals

A very short experiment was performed (in mid-March 2006) to estimate growth of India and China articles in high Impact Factor journals. The journals cited most frequently by Indian and Chinese authors have substantial overlap. They are the well-recognized high quality journals. Three of the five most highly cited journals (one in each of the following disciplines: chemistry, physics, biology) were selected, and the numbers of papers published with India authors and with China authors were examined as a function of time. The trends are:

| YEAR | JACS INDIA | CHINA | P REV LETT INDIA | CHINA | J BIO CHEM INDIA | CHINA |
|---|---|---|---|---|---|---|
| 1995 | 5 | 2 | 34 | 14 | 9 | 2 |
| 1996 | 17 | 5 | 49 | 33 | 13 | 2 |
| 1997 | 17 | 11 | 52 | 31 | 17 | 7 |
| 1998 | 23 | 12 | 66 | 56 | 10 | 7 |
| 1999 | 11 | 13 | 51 | 39 | 23 | 16 |
| 2000 | 19 | 35 | 54 | 70 | 17 | 25 |
| 2001 | 15 | 49 | 59 | 85 | 42 | 46 |
| 2002 | 14 | 45 | 49 | 82 | 31 | 56 |
| 2003 | 19 | 89 | 55 | 134 | 60 | 83 |
| 2004 | 15 | 99 | 50 | 151 | 54 | 110 |
| 2005 | 27 | 142 | 52 | 158 | 44 | 124 |
| 2006 | 4 | 22 | 8 | 28 | 2 | 13 |

CODE:
JACS=Journal of the American Chemical Society

P REV LETT=Physical Review Letters
J BIO CHEM=Journal of Biological Chemistry

Prior to the mid-1990s, the India and China article numbers were relatively low in these journals. India had noticeably more publications in the three journals prior to about 2000. Since 2000, China has noticeably more publications than India in these journals, and the lead over India is increasing.

How does the growth in these three highly cited journals compare with the overall research article growth of India and China (shown previously) in this period? From 1995 to 2000, India's overall article growth increased by about a third (16203/ 12602). In the above table, in all three journals, India's growth over this period is greater than a third, ranging from factors of 1.5 to four. From 1995 to 2000, China's overall article growth increased by almost a factor of three (29292/ 11402). In the above table, China's increase over the same period ranged from factors of five to ten, outpacing its overall growth, and noticeably greater than India's.

From 2000 to 2005, India's overall article growth was about 50% (25367/ 16203). In the above table, India's article growth ranged from factors of zero to 2.5, on average matching its overall article growth during this period. China's overall article growth during this period was about a factor of 2.5 ((72310/ 29292), while China's article output growth in the above table ranged from factors of 2.2 to five, thereby outpacing its total article growth once again. Thus, for this admittedly limited sample of the highest cited discipline journals by China and India, ***China strongly outpaced India in growth over the time period examined, and outpaced its own overall research article growth as well.***

The message to be taken from this analysis is that ***<u>both India and China are increasing their growth of articles in highly cited journals greater than their overall increase in growth of research articles</u>.*** India's relative increase is modest, whereas China's increase is strong. For both countries, much of the increase in overall research article growth comes from increasing production of articles in low Impact Factor domestic and international journals. Also, for both countries, there is increased production in high Impact Factor journals as well. The increase in high Impact Factor journals outpaces the increase in overall research article production, but the *high Impact Factor journal production is a relatively small fraction of the overall research article production*.

D2.1.3. Journals Containing Most India-authored Articles

For India, the highest ranking journals emphasize chemistry, veterinary, agriculture, and physics, in that order. For China, the order is physics, materials, chemistry, showing a definite difference in emphases. The only high ranking journal common to both countries is Acta Crystallographica. For India, eleven of the top 21 journals appear to be domestic Indian journals, whereas for China, ten of the top 20 journals appear to be domestic Chinese journals. In both cases, the journal Impact Factors are relatively low. For India, fifteen of the top 21 journals have Impact Factor less than unity. For China, fourteen of the top 20 journals have Impact Factor less than unity. Especially for China, almost all the journals recently accessed by the SCI/ SSCI have Impact Factors below unity. By comparison, the median Impact Factor of the 20 journals containing the most USA articles for 2005 is ***an order of magnitude higher than that of India or China***.

There are many causes that can contribute to low journal Impact Factor. These include low quality publications and/ or limited journal circulation and/ or overly applied papers and/ or technical field covered (i.e., number of researchers working in technical field and available to cite papers). This study did not distinguish among these causes for the journals listed above.

D2.1.4. Impact of Collaboration on Journals Selected for Publication

How does collaboration among India and other countries impact the journals in which Indian authors publish? A very brief analysis was performed. Two cases were examined, and compared. The first case represents articles that could have included participation among India and other countries. The second case represents articles published essentially exclusively by India authors. The differences between the two cases represent the impact of collaboration.

In the first case, all research articles in the SCI/ SSCI having at least one author with an India address, and publication date of 2005, were retrieved. There were 25367 records. In the second case, all research articles in the SCI/ SSCI having at least one author with an India address, a publication date of 2005, but excluding authors from (USA or Japan or Germany or

Hong Kong or (England Not New England) or Canada or Italy or France or Australia or South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran) were retrieved. There were 20672 records retrieved, a 25% reduction from the collaborative case.

A small sample of high Impact Factor journals was examined. The results are unmistakable!

| JOURNAL | INDIA ONLY | INDIA & COLLAB | IMPACT FACTOR |
|---|---|---|---|
| Nature | 1 | 8 | 32.18 |
| Science | 2 | 8 | 31.85 |
| Physical Review Letters | 25 | 106 | 7.22 |
| PNAS-USA | 5 | 14 | 10.45 |

***Collaboration has the effect of dramatically increasing the presence of papers with India authors in the higher Impact Factor journals.***

D2.1.5. Most Cited Journals

In contrast to journals containing most country papers for India and China, where only one journal was in common, there are fifteen journals in common (~3/4) out of the 20 most cited journals by each country. The Impact Factors for these most cited journals are an order of magnitude higher than the Impact Factors for the journals that contain the most India or China papers. Thus, as was the case for the China study, India authors are citing the high Impact Factor journals extensively, but not publishing in them extensively. *Both India and China authors are increasing their presence in these high Impact Factor journals, but they are presently over-concentrated in the lower Impact Factor journals*.

D2.1.6. Most Prolific Institutions

Two institutions stand out in terms of productivity: Indian Institute of Technology (actually, an aggregate of six IITs) and Indian Institute of Science. Of the 20 most prolific institutions, eighteen are universities, and the other twelve are research institutes, including one Chinese institute.

D2.1.7. Cross-Institution Collaboration

Which institutes collaborate significantly on publications? To identify cross-institution collaboration, an institution-institution co-occurrence matrix was generated. The major institutional collaborators for the top five institutions are as follows (collaborator/ [# papers]):

- Indian Institute of Technology (Tata IFR [23], Bhabha ARC [20], IIS [19], NIT [14], Punjab U [11], Indira Gandhi CAR [10])
- Indian Institute of Science (IIT [19], U Madras [7], Tata IFR [6], U Mysore [5])
- Bhabha ARC (IIT [20], Banaras HU [15], Tata IFR [7], Punjab U [6])
- Univ Delhi (Tata IFR [18], Punjab U [17], IIT [5], All India IMS [5])
- Tata IFR (Punjab U [57], Chinese Acad Sci [31], IIT [23], U Delhi [18])

An auto-correlation map of the 30 most prolific institutions (using the TechOasis software package) showed that no strongly connected publishing groupings are evident, but five moderately connected publishing groupings can be identified:

- University of Madras-centered group
- Punjab University-centered group
- University of Calcutta-centered group
- Bhabha ACR-centered group
- Because of its sheer magnitude, the Indian Institute of Technology has to be included as a self-contained group

Equally important, the two most prolific institutions, Indian Institute of Technology and Indian Institute of Science, were not shown connected to any other institutions, based on the connectivity threshold necessary to display linkages.

To obtain a more quantitative perspective on institution co-publishing relationships, a factor analysis was performed on the most prolific institutions. For the thirty most prolific institutions, a five factor institution factor matrix showed the presence of the following five distinct groupings, one for each factor.

- University of Madras strongly linked to Indian Institute of Chemical Technology, and weakly linked to Anna University, Punjab University, Tata IFR, and Chinese Academcy of Science.
- Punjab University strongly linked to Tata IFR and Chinese Academy of Science, and weakly linked to University of Delhi.
- University of Calcutta strongly linked to Jadavpur University, Saha INP, and Indian Statistical Institute, and weakly linked to Indian Association of Cultivation Science.
- Indian Institute of Technology with very weak links (same sign of factor loadings) to National Institute of Technology, University of Calcutta, Indira Ghandi ACR, and University of Madras.
- Bhabha ARC strongly linked to Banaras Hindu University and Indira Ghandi CAR, and weakly linked to Annamalai University.

Thus, the main groupings from the auto-correlation institution map are reproduced in the five factor matrix, with some additional information provided on the very weak linkages (especially for Indian Institute of Technology).

To identify institutional linkages based on common use of technical terminology (a proxy for common technical interests), an institution-phrase co-occurrence matrix was generated. The major phrases for the top five institutions are as follows (phrase, freq):

IIT (temperature 86, physics 75, water 56, synthesis 50, reaction 45, flow 44, surface 43, stability 40, structure 38, pH 38, concentration 34, compounds 33, room temperature 31, materials 31)
IIS (structure 37, temperature 28, physics 25, proteins 21, crystal structure 19, water 18, synthesis 18, surface 18, flow 16, stability 16, structures 14, species 14, protein 14, title compound 14, concentration 13, films 13, layers 13, crystal structures 13)
BhaBha (temperature 26, concentration 16, room temperature 16, structure 14, physics 13, water 12, compound 12, Au+Au collisions 12, complexes 11, reaction 10, pressure 10, pH 10, reactions 10, synthesis 9, growth 9, Co 9, particles 9, films 8, stable 8, treatment 8, ions 8)
U Delhi (complexes 18, films 16, synthesis 13, treatment 13, IR 13, Fermilab Tevatron collider 12, temperature 10, Cl 10, compounds 9, elemental analysis 9, patients 9, molar conductance 9, concentration 8, mass 8, inhibition 8, bacteria 8, NO3 8)

Tata IFR (Belle detector 31, physics 27, Fermilab Tevatron collider 15, temperature 14, magnetization 14, compounds 12, compound 10, protein 7, room temperature 7, transition 7, simulations 7, T-c 7, proteins 6, K 6, electron 6, signal 6, electrical resistivity 6, magnetic field 6)

To display these results graphically, an institution-phrase cross-correlation map was generated. This map (generated with the TechOasis software) related institutions by their common use of terminology, and thereby reflected common technical interests among institutions. Use of this cross-correlation map in conjunction with the auto-correlation map, in addition to use of the other institutional proximity indicators, showed the importance of using multiple analytical techniques when assessing bibliometrics results.

The institutional collaboration structure had some significant differences from the collaboration structures shown on the auto-correlation map or in the factor matrix. Most importantly, the cross-correlation map showed a bi-polar central core of Indian institutional research based on common terminology, centered about the ***highly connected*** major institutions Indian Institute of Science (basic research - proteins, crystals, microfilms) and Indian Institute of Technology (applied research - flow, simulations, macrofilms). ***On the auto-correlation map, these institutions appeared as stand-alones***, based on the threshold level of connectivity necessary for displaying linkages!

One interpretation of the difference between the cross-correlation map structure and the previous structures is that the Indian Institute of Science and the Indian Institute of Technology are working the same general research areas as a number of other institutions, but they are not collaborating on publications to the same extent. This may be due to overlap at a generic level of technical description, but distinctness at the much more detailed level of technical description required for collaborative research and publication. Or, it may be due to a tradition of more independent research and publication practices. A more detailed examination of the collaborative practices among the institutions located in the core structure of the cross-correlation map might prove fruitful and cost-effective. ***This approach of comparing institution auto-correlation maps with institution cross-correlation maps may prove to be a powerful approach for identifying institutions that are related by common interests, but are not collaborating accordingly.*** This auto/ cross-correlation map comparison approach need not be limited to institutions, It is equally applicable to authors, countries, and other categories,

From the cross-correlation map, a few other technically-based groupings can be discerned. There is a medical group (All India IMS, Postgraduate Inst MER, Central Drug Res Inst) that includes a focus on infections, the high energy physics group (common terminology of Belle Detectors, Fermilab Tevatron Collider) identified previously (Tata IFR, Panjab University, Chinese Academy of Sciences), a chemistry-oriented group (Indian Institute of Chemical Technology, University Mysore, Anna University, National Chemical Lab) emphasizing catalysis and crystal structures, and a medical lab experiment group (University of Madras, Annamalai University) that includes an emphasis on animal experiments for liver problems.

D2.1.8. Institution Publishing Preferences

To identify preferred institutional publishing venues, an institution-journal co-occurrence matrix was generated. The major journals for the top five institutions are as follows (journal [# papers]):

- Indian Institute of Technology (Journal of Applied Physics [40], Tetrahedron Letters [18], Transactions Of The Indian Institute Of Metals [17], Physical Review B [15], Journal of Chemical Physics [13]Journal of Physical Chemistry B [12], Physica B-Condensed Matter [12], Pramana-Journal of Physics [11], Current Science [11])
- Indian Institute of Science (Physical Review B [20], ACTA Crystallographica Section E-Structure Reports Online [13], Physical Review Letters [13], Journal of Physical Chemistry B [13], Current Science [12], Pramana-Journal of Physics [10])
- Bhabha Atomic Research Center (Physics B – Condensed Matter [8], Journal of Chemical Physics [8], Journal of Physical Chemistry B [7])
- University Delhi (Spectrochimica Acta Part A-Molecular And Biomolecular Spectroscopy [13], Physical Review D [10], Current Science [9])
- TATA Inst Fundamental Res (Physical Review Letters [37], Physical Review D [22], Journal of Applied Physics [15], Physical Review B [15])

The thrusts of each institution can be seen from analysis of the leading journals in which its research is published. The Indian Institute of Technology covers a broad range of physics, chemistry, and materials, with an emphasis on physics, mainly applied. The Indian Institute of Science emphasizes the more fundamental aspects of physics, materials, and chemistry. Bhabha ARC emphasizes physics strongly, with some chemistry as well. University of Delhi emphasizes spectroscopy and physics, whereas Tata focuses very strongly on physics.

In aggregate, these five institutions have a strong focus on physics, followed by thrusts in chemistry and materials. Additionally, the journals in which they publish tend to be the more well-known higher Impact Factor journals (with some exceptions), as opposed to the low Impact Factor high frequency journals identified during the overall India publication analysis. ***This provides further evidence of the deficiencies in drawing conclusions about a country's S&T enterprise based on aggregate country bibliometrics, and suggests strongly that institution and technical discipline stratifications are important in determining quality of publication venues.***

D2.1.9. Major Collaborating Countries

In March 2006, the SCI was accessed to identify the main collaborating countries with India on research articles, in the period 2004-2005. The results are as follows. The format is the name of the country, followed by the number of articles that contained at least one country author and one India author.

**India (46483), USA (3194), Germany (1441), Japan (1067), England (872), France (711), China (669), South Korea (553), Canada (435), Italy (419), Australia (387), Russia (316), Spain (268)**

D2.1.10. Citation Impact of Collaboration

What is the citation impact of collaboration? Two cases were compared. The first case consisted of all research articles in the SCI published from 1995-1999 having at least one author with an India address. The second case consisted of all research articles in the SCI published from 1995-1999, retrieved using the following address query that essentially generates India-only authored articles: (India Not (USA or Japan or Germany or Hong Kong or (England Not New England) or Canada or Italy or France or Australia or

South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran)) These countries were the main research collaborators with India in the 1995-1999 time frame.

The first case (India and collaborators) produced the following results:

- Articles retrieved, 76717;
- Median citations of total articles retrieved, 2;
- Median citations of top ten cited articles retrieved, 453;
- Median citations of top 5% articles retrieved, 29.

The second case (India only) produced the following results:

- Articles retrieved, 66896;
- Median citations of total articles retrieved, 2;
- Median citations of top ten cited articles retrieved, 212;
- Median citations of top 5% articles retrieved, 24.

Thus, approximately fifteen percent of research articles having at least one author with an India address were the result of India's collaboration with other countries. ***The impact of collaboration was negligible on median citations of the total retrieval. The impact of collaboration was substantial on the top ten cited articles, and was noticeable on the top 5% of cited articles.***

D2.1.11. Main Technical Areas of Collaboration

What are the main technical areas of collaboration? The only collaboration studied was USA-India. Further, it was decided to eliminate massive multi-country studies that tend to include authors from many countries. These tend to be large drug trials, or space experiments, or astronomy experiments, etc., and the role India plays in many of these large studies is unknown. Papers that had only USA-India authors, and were published in 2005, were downloaded from the SCI/ SSCI. These papers reflect specific India-USA mutual interests. The download query used was (in the address field):

***(India and USA) not (Japan or Germany or Hong Kong or (England Not New England) or Canada or Italy or France or Australia or South Korea or Taiwan or Netherlands or Sweden or Russia or Peoples R China or Singapore or Switzerland or Spain or Brazil or Scotland or Finland or Malaysia or Romania or Austria or Belgium or Iran))***

A phrase frequency analysis of the Abstracts was performed, and the highest frequency high technical content phrases were extracted. <u>The two areas that stand out are biomedical and nanotechnology.</u>

<u>D2.2. Selected Single Technology Bibliometrics</u>

Four technical disciplines were selected to represent pervasive thrust areas of Indian research: Crops; Films; Alloys; Infectious Diseases.

D2.2.1. Crops

For Crops, the first two journals on the prolific journals list, both Indian journals, dominate the list, and provide the impression of local relevance topics. Both journals are very applied. Only a few fundamental science journals are listed (e.g., Theoretical and Applied Genetics, Asian Journal of Chemistry), enforcing the impression of very applied research.

The most dominant Crops institution, from the perspective of numbers of publications, is the Indian Agricultural Research Institution. Of the 20 most prolific institutions, twelve are universities, and the remaining eight are research institutions. Seven of the twelve universities are agricultural universities specifically. This balance suggests relatively applied research on agriculture.

The USA is the dominant Crops collaborator by far, followed by a second tier of England, Phillipenes, Germany, and Japan. This is the first time Phillipenes has appeared in any of the most prolific country lists of the first author's text mining studies, and its presence in the midst of the high tech top tier countries stands out. The presence of Philippines in this list has strong reasons. International Rice Resarch supported by Food and Agricultural Research Organisation of the UN is in the Philippines. This is a premier international organisation in rice research. This institute has very strong linkages with Indian Agricultural Research Institute and significant collaborative research is undertaken jointly between these two organisations.

The most cited Crops journals are, on average, more fundamental than the prolific journals in the previous section. While the fraction of Indian journals is about the same in both lists, the Indian journals are lower in the rankings of the most cited.

Compared to other technical areas examined in the first author's previous text mining studies, the most cited papers in India Crops research are quite dated. Eight of the ten documents listed are pre-1980, and the remaining two were published in the 1980s. The datedness does not suggest a dynamic research field. The more field-specific documents focus on soil chemical properties, whereas the more generic documents, focus on plant molecular and cell phenomena.

D2.2.2. Films

Based on the computational linguistics (document clustering) results, Thin Films is an important area of Indian research. Only two of the top twenty most prolific journals containing Films articles are Indian, and they are lower in the rankings. Most of the journals are applied, confirming the conclusions based on the prolific authors' institutions. The main focus is on physics, with strong emphasis on materials and chemistry as well.

Ten of the most prolific Films institutions are universities, and the remaining twelve are research centers. This provides further evidence of the applied nature of the work. Curiously, four of the institutions are nuclear/ atom research focused. Since films are surface phenomena, with charged particle and Van Der Waals forces predominating, and EV-level charged particle binding energies, why are organizations focused on nuclear forces and their associated MEV-level nuclear binding energies involved so heavily?

Three major collaborating countries stand out (USA, Germany, and Japan), with the next tier consisting of a balance of advanced Western European countries (France, England, Italy) and rapidly developing Asian countries (South Korea, Taiwan, China).

Physics journals, both basic and applied, are the most highly cited, followed by chemistry journals.

The most cited documents are much more recent than those in the Crops example. Nine of the documents are later than 1980, suggesting a much more dynamic research area. The more recent documents seem to focus on film resistance, while the older documents address the more general electronic processes in materials.

D2.2.3. Alloys

Based on the computational linguistics (document clustering) results, Alloys is an important area of Indian research. Almost all the prolific journals listed are applied. All the top journals focus on materials, and only near the bottom of the list do more fundamental and generic journals appear (e.g., Physical Review, Bulletin of Electrochemistry).

Out of 21 institutions listed, only seven are universities. This suggests further a very applied focus. Two of the top three institutions are atomic research centers.

The major collaborating partners in Alloys are Germany and the USA, in that order. The reasons for the USA ranking second as collaborator (whereas they rank first in the other three research areas studied) are unclear, and require further study. The next tier consists of Japan and China.

While there are still a relatively large number of materials journals listed as most cited, some physics journals do appear, especially Phys Rev B (the leader), J Appl Phys, and Phys Rev Lett.

Most of the highly-cited documents are very applied and material specific. They are also much more recent than the most cited Crops papers, all Alloys papers being post-1980, with half being in the 1980s, and the remainder post-1990.

D2.2.4. Infectious Diseases

Based on the computational linguistics (document clustering) results, Infectious Diseases is an important area of Indian research. The top three prolific journals are Indian, with an emphasis on animal infectious diseases. Fundamental biology and other broader science disciplines are few, and rank lower on the list. None of the major science journals (Science, Nature) or medical journals (JAMA, NEJM, Lancet) are represented on this list.

# DISCUSSION AND CONCLUSIONS

Empirical evidence validates the results of computational linguistics. Anti-infectives are the largest therapeutic segment in the Indian pharmaceutical industry, accounting for 19% of market share (ICRA, 2004). Lack of:

- proper sanitation conditions,
- hygiene,
- availablilty of healthcare

had primarily contributed to the high incidence of infectious diseases in India. It is not surprising to note that international journals do not reflect Indian research on infectious diseases. There are many local/specific problems of interest to Indian journals that are not in the domain of international attention.

Fifteen institutions are research institutes, and the remaining five are universities. This imbalance suggests extremely applied research.

The USA is by far the leading collaborator, with England constituting the second tier. Japan and Germany are the third tier, well behind the second tier.

Most of the previous text mining studies of the first author have shown strong overlap between the journals containing the most papers and the most cited journals. In the present case, there is weak overlap, with only five journals (Journal Of Clinical Microbiology, Journal Of Biological Chemistry, Journal Of Infectious Diseases, Indian Journal Of Medical Research, American Journal Of Tropical Medicine And Hygience) being shared by both lists. Many of the journals uniquely contained on the most cited list are fundamental research journals, and more well-known and recognizable basic science and medical journals (Nature, Science, Lancet, NEJM are also contained on the most cited list.

Half the most cited documents are pre-1980 vintage, and these older papers focus on protein determination and analysis. Two of the more recent papers focus on tuberculosis, and the others address molecular sub-cell issues.

An interesting pattern has emerged on the most cited documents. Two of the disciplines analyzed, Crops and Infectious Diseases, represent two different aspects of the Bio category. The other two disciplines analyzed, Films and

Alloys, represent two different aspects of the Physical Sciences category. The most cited papers in the Crops and Infectious Diseases disciplines tend to be quite old, and many of them are classical references with extremely large numbers of citations. The most cited papers in the Films and Alloys disciplines are of much more recent vintage, suggesting more dynamic research disciplines.

D2.3. Aggregate Selected Technology Bibliometrics Conclusions

The four selected technologies on which the bibliometrics were performed reflected efforts at a large number of institutions. Relatively few institutions had a significant presence in more than one of these technologies. Table 18 shows the main institutes that had a significant presence in multiple technologies. The first number in each matrix element is the number of papers published by the institution for the specific technology, and the second number is the ranking of the institution in numbers of papers for the specific technology. Thus, for example, the Indian Institute of Science published 148 papers in Films, and ranked second of all institutions publishing in Films.

## TABLE 18 – LEADING INSTITUTIONS IN CORE COMPETENCIES

**INDIAN INSTITUTION PRESENCE IN FOUR CORE COMPETENCIES**

| INSTITUTION | CROPS | FILMS | ALLOYS | INFECT |
|---|---|---|---|---|
| Indian Institute Of Technology | 68/3 | 329/1 | 486/1 | |
| Indian Institute Of Science | | 148/2 | 129/4 | 81/3 |
| University Of Delhi | 43/9 | 64/7 | | 45/10 |
| Banaras Hindu University | 37/11 | 27/22 | 71/8 | |
| Bhabha Atomic Research Center | | 78/6 | 149/3 | |
| Indira Ghandi Center For Atomic Research | | 56/10 | 171/2 | |
| Central Electrochemical Research Institute | | 40/15 | 45/11 | |
| Tata Institute Of Fundamental Research | | 45/12 | 29/14 | |
| Shivaji University | | 60/8 | 22/21 | |
| Center For Advanced Technology | | 29/19 | 24/18 | |
| Anna University | | 27/21 | 28/16 | |

The first tier institutions, in numbers of papers, ranking, and multiple disciplines, are the Indian Institute of Technology and the Indian Institute of Science. It should be emphasized that these rankings are based on production. It should also be noted that the output of Indian Institute of

Technology is aggregated output of six IITs. Quality, based on citations or other criteria, was not measured.

The second tier institutions are University of Delhi and Banares Hindu University. Both have a presence in three disciplines. The third tier contains the two atomic research centers, and the remainder of the institutions on the list constitutes the fourth tier.

A modest number of countries had significant presence in multiple disciplines. Table 19 lists the countries, and shows the number of publications and rankings in the different disciplines. These countries are the major collaborators with India in these disciplines.

## TABLE 19 – CORE COMPETENCY COLLABORATORS

**COLLABORATING COUNTRY PRESENCE IN FOUR CORE COMPETENCIES**

| COUNTRY | CROPS | FILMS | ALLOYS | INFECT |
|---|---|---|---|---|
| Usa | 101/1 | 101/1 | 86/2 | 186/1 |
| Germany | 22/4 | 82/2 | 104/1 | 22/4 |
| Japan | 21/5 | 67/3 | 57/3 | 26/3 |
| England | 30/2 | 27/7 | 32/5 | 54/2 |
| France | 10/10 | 49/4 | 23/6 | 17/5 |
| China | 11/8 | 19/9 | 53/4 | 14/9 |
| South Korea | 6/16 | 47/5 | 24/7 | 9/16 |
| Australia | 15/6 | 6/15 | 10/11 | 17/7 |

The first tier collaborator is clearly the USA. It ranks first in three disciplines, and second to Germany in Alloys. The second tier consists of Germany, Japan, and England. Thie third tier is France and China, followed by the fourth tier of South Korea and Australia.

The USA and Japan are relatively balanced in their presence across all disciplines. Germany and South Korea seem to emphasize the two Physical Sciences areas of Films and Alloys, whereas England and Australia place more relative emphasis on the Environmental/ Biomed areas of Crops and Infectious Diseases.

### D2.4. Citation Comparison With China

India's research was compared with that of China, based on citations received by papers published in 1998 on myriad S&T topics. Different phrases were chosen to represent four separate research categories: Physical Sciences, Environmental/ Agricultural Sciences, Life Sciences, and Materials Sciences. Ordinarily, Engineering Sciences is used rather than Materials Sciences, but there were insufficient phrases with adequate frequencies to represent Engineering Sciences, so Materials Sciences was used instead. These four research categories are assumed to cover most of science.

Each phrase could be perceived as representing a specific technical discipline within one of the four broader categories defined above. Each phrase was used as a query, and inserted in the SCI search engine for 1998. The citation performance of the ten most cited papers for each technology for each country was compared, and the median of the top ten was the final metric employed.

The phrases (technologies) were grouped by major category. The first group is Physical Sciences. Out of twenty phrases examined, representing diverse areas of Physical Sciences, China was a clear winner in fifteen, India led in one, and four were viewed as even. Clearly, China is the leader in Physical Sciences, based on median numbers of citations.

The second group is Environmental Sciences. Out of ten phrases examined, China was the clear leader in seven, and three were considered even. Clearly, China is the leader in Environmental/ Agricultural Sciences.

The third group is Material Sciences. Out of ten phrases examined, China was the clear leader in seven, India was the clear leader in two, and one was considered even. Clearly, China is the leader in Material Sciences.

The fourth group is Life Sciences. Out of ten phrases examined, China was the clear leader in nine, and one was considered even. Clearly, China is the leader in Life Sciences.

Thus, China was the clear leader in each major category, although there were (isolated) instances where India led in a sub-technology area.

D2.5. Structure of India's Research Literature – Taxonomy

The following diagram is a four level hierarchical taxonomy of India's research literature. The themes of each level's categories and the associated numbers of records in each category are shown as follows.

<table>
<tr><th>LEVEL 1</th><th>LEVEL 2</th><th>LEVEL 3</th><th>LEVEL 4</th></tr>
<tr><td rowspan="6">(5513) BIOMEDICAL; ENVIRON</td><td rowspan="3">(2626) BIOLOGICAL RESEARCH</td><td rowspan="2">(1458) ANIMAL EXPERIMENTS/ PLANT BIOLOGY</td><td>(807) PLANT BIOLOGY</td></tr>
<tr><td>(651) ANIMAL EXPERIMENTS</td></tr>
<tr><td colspan="2">(1168) CELL BIOLOGY/ GENETICS</td></tr>
<tr><td rowspan="3">(2887) CLINICAL MEDICINE; ENVIRON</td><td colspan="2">(1218) HUMAN PATIENT DISEASES</td></tr>
<tr><td rowspan="2">(1669) GEOLOGICAL/ MAT'L MECHANICS/ AGRICULTURAL RES</td><td>(952) SOIL/ CROP EXPERIMENTS</td></tr>
<tr><td>(717) GEOLOGICAL RES/ MATERIAL MECHANICS</td></tr>
<tr><td rowspan="7">(8795) PHYSICAL SCIENCES/ MATHEMATIC</td><td rowspan="3">(3691) MATHEMATIC</td><td colspan="2">(1372) ALGORITHMS/ NETWORK MODELING</td></tr>
<tr><td rowspan="2">(2319) MATH ANALYSIS</td><td>(1255) CONTINUUM ANALYSIS</td></tr>
<tr><td>(1064) MOLEC LEVEL CALC</td></tr>
<tr><td rowspan="4">(5104) PHYSICAL SCIENCES</td><td rowspan="2">(2867) SURF PHYS/ CHEM</td><td>(1576) FILM PHYS</td></tr>
<tr><td>(1291) FILM CHEM</td></tr>
<tr><td rowspan="2">(2237) COMPOUND CHEMISTRY</td><td>(939) CHEM BOND/ CRYS STRUCT</td></tr>
<tr><td>(1298) REACT/ CATAL/ SYNTH</td></tr>
</table>

Level 1 is divided into two categories: Biomedical/ Environment (5513) and Physical Sciences/ Mathematics (8795). **Biomedical/ Environment** covers biological and medical research, as well as agricultural and environmental research

(THEMES: patient 4.0%, cell 2.0%, activ 1.7%, protein 1.7%, level 1.5%, plant 1.1%, gene 1.1%, treatment 1.0%, isol 0.9%, speci 0.8%, control 0.8%, extract 0.7%, soil 0.7%, enzym 0.7%, infect 0.7%, acid 0.6%, rat 0.6%, induc 0.6%, strain 0.6%, (22.60%); KEYWORDS biochemistry & molecular biology 402; india 251; multidisciplinary sciences 189; environmental sciences 189; food science & technology 185; chemistry, medicinal 173; biotechnology & applied microbiology 172; plant sciences 171; pharmacology & pharmacy 170; plant sciences 161; geosciences, multidisciplinary 161; surgery 154; agronomy 147; growth 147; agriculture, dairy & animal science 146; immunology 141; expression 137; pharmacology & pharmacy 134; cell biology 134; biophysics 129).

**Physical Sciences/ Mathematics** covers physics, chemistry, and mathematics, with a strong emphasis on the physics and chemistry of surfaces

(THEMES: temperatur 1.8%, model 1.4%, complex 1.4%, reaction 1.2%, structur 1.1%, phase 1.1%, ion 1.0%, film 1.0%, system 1.0%, solut 0.9%, energi 0.8%, state 0.7%, compound 0.7%, acid 0.7%, electron 0.7%, paramet 0.7%, crystal 0.7%, two 0.6%, properti 0.6%, (18.70%);
KEYWORDS: chemistry, multidisciplinary 797; chemistry, organic 642; chemistry, physical 621; materials science, multidisciplinary 538; physics, multidisciplinary 488; physics, condensed matter 324; engineering, electrical & electronic 322; polymer science 309; chemistry, inorganic & nuclear 279; physics, applied 264; crystallography 261; physics, atomic, molecular & chemical 254; chemistry, analytical 236; derivatives 212; materials science, multidisciplinary 211; behavior 201; engineering, chemical 198; model 195; systems 193; physics, condensed matter 186).

Level 4 is divided into sixteen categories, and treated as a flat taxonomy. Each category is briefly described in order of its listing in the diagram, starting from the top. The metrics, shown in the main body, have been excluded from this summary.

- **Plant Biology (807)**

This category focuses on plants and seeds, especially the extraction of oils from seeds, and has a food technology emphasis. It appears quite applied, and the main institutions are agriculture-food focused. Other Asian countries play a role equal to that of the USA, although the relatively small amount of Chinese collaboration is somewhat surprising.

- **Animal Experiments (651)**

This category focuses on laboratory experiments for addressing diseases, especially for testing the impacts of drugs. The two main institutions, University of Madras and Annamalai University were identified on Figure 2B as having common interests in liver problems especially, and this category confirms that previous finding.

- **Cell Biology/ Genetics (1168)**

This category focuses on cell biology and genetics, especially proteins and gene expression. It is one of the more fundamental research categories, as evidenced by the journals and terminology. As expected, the USA is by far the major collaborator in this fundamental research area.

- **Human Patient Diseases (1218)**

The focus here is clinical patient treatment, with emphasis on treatment of infections, especially HIV. Again, the USA is the major partner, with the Western democracies playing strong roles.

- **Soil/ Crop Experiments (952)**

The focus is study of soils and plant genetics to improve crop yields. It is more fundamental than the related Plant Biology category, as evidenced by the major journals, keywords, and institutions. The USA is a more dominant collaborator than in the Plant Biology category.

- **Geological Research/ Material Mechanics (717)**

This category has two dis-similar thrusts: Geological and associated environmental research, and the mechanics of materials. The common links that resulted in these thrusts appearing in the same category are stresses in solid materials and mechanical properties of materials. The next level of dis-aggregation would probably result in separation of these thrusts into different categories. The geological thrust focuses on sediments, and the materials thrust focuses on welding.

- **Algorithms/ Network Modeling (1372)**

Focuses on algorithms and modeling of networks, especially communications. China plays a noticeable collaborative role in this technology-oriented category.

- **Continuum Analysis (1255)**

Focuses on equations modeling continuum fields, especially flow fields and wave equations. Emphasizes mechanics, mainly fluid but some solid as well.

- **Molecular Level Calculations (1064)**

Physics-oriented category. Focuses on energy states, and calculations at the atomic and molecular level. Strong levels of co-authorship. Basic research, published in more well-known physics journals. Large international high energy physics experiments involved.

- **Film Physics (1576)**

***CATEGORY HAS TWO MAIN THRUSTS: SMALL-SCALE FILM MEASUREMENTS AND FILM DEPOSITION AND GROWTH***

**Small-Scale Film Measurements (1166 Records)**
**Film Deposition and Growth (410)**

Focuses on surface physics/ films. Main thrusts are small-scale film measurements and film deposition and growth. In both thrusts, USA is eclipsed as dominant collaborator by an Asian country.

- **Film Chemistry (1291)**

***CATEGORY HAS TWO MAIN THRUSTS: POLYMER CHEMISTRY/ PROPERTIES AND SURFACE WET CHEMISTRY***

**Polymer Chemistry/ Properties (479 Records)**
**Surface Wet Chemistry (812 Records)**

Focuses on film chemistry, mainly polymer chemistry/ properties and surface wet chemistry. Polymer work appears quite applied.

- **Chemical Bonds/ Crystal Structures (939)**

CATEGORY HAS TWO MAIN THRUSTS: LIGAND-METAL COMPLEX SYNTHESIS AND COMPOUND HYDROGEN BONDS

**LIGAND-METAL COMPLEX SYNTHESIS (460 Records)**
**COMPOUND HYDROGEN BONDS (479 Records)**

Focuses on chemical bonds and crystal structures, emphasizing ligand-metal complex synthesis and compound hydrogen bonds. Ligand-metal synthesis emphasizes domestic journals, and is relatively more applied than hydrogen bond work.

- **Reactions/ Catalysis/ Synthesis (1298)**

Applied organic chemistry category, emphasizing chemical reactions, catalysis, and synthesis.

## D2.6. Relation between Expenditures and Output

Finally, the relation between the research expenditures in different technical categories and the sixteen categories of research output aricles above is examined. There were four main categories of expenditures (category/ % of budget):

- Natural Sciences (21%)
- Engineering & Technology (50%)
- Medical Sciences (8%)
- Agricultural Sciences (20%)

The sixteen research output categories can be classified under the four research expenditure categories in the following very approximate manner:

- Natural Sciences (21%)
  - Continuum Analysis (1255)
  - Molecular Level Calculations (1064)
  - Film Physics (1576)
  - Film Chemistry (1291)
  - Chemical Bonds/ Crystal Structures (939)
  - Reactions/ Catalysis/ Synthesis (1298)

- Engineering & Technology (50%)
  - Geological Research/ Material Mechanics (717)
  - Algorithms/ Network Modeling (1372)

- Medical Sciences (8%)
  - Animal Experiments (651)
  - Cell Biology/ Genetics (1168)

  - Human Patient Diseases (1218)

- Agricultural Sciences (20%)
  - Plant Biology (807)
  - Soil/ Crop Experiments (952)

The relation between the percentage of expenditures assigned to the four funding categories and the percentage of articles assigned to these same categories is as follows (category name/ expenditure percent/ article percent):

- Natural Sciences (21%/ 52%)
- Engineering & Technology (50%/ 15%)
- Medical Sciences (8%/ 21%)
- Agricultural Sciences (20%/ 12%)

While different assignments of the sixteen output categories to the four expenditure categories are certainly possible (for example, one could argue that the continuum analysis category of fluid and solid mechanics is really an engineering category), nevertheless, the above imbalances are probably real. The main imbalance appears to be between the Natural Sciences and the Engineering and Technology expenditure categories. The articles in the Natural Sciences categories covered fields such as physics, chemistry, and mathematics. However, there was much applied work in each of these component fields. If the more applied research in these component fields were viewed as Technology, and transferred from the Natural Sciences category to the Engineering and Technology category, the major imbalance would be redressed substantially. In order to make this determination of basic/ applied fractions, a much larger number of research output categories (clusters) with much more narrowly defined themes would have to be generated. These smaller clusters would probably separate into basic/ applied. The present level of research output category resolution does not allow this separation.

The primary objective of this study was to examine the structure of India's research at the higher levels. Accordingly, the sixteen categories are at a relatively coarse level of resolution. In particular, much more accurate results relating research outputs to research expenditures (above) would be possible with much more well-defined categories. An assessment oriented toward more specific technology analyses would require narrower more well-defined clusters, translating into using a larger number of clusters. The present technique is fully translatable into analyzing hundreds or thousands of clusters.

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# APPENDICES

## APPENDIX 1 – INDIA SCIENCE AND TECHNOLOGY ORGANIZATION

### Introduction

India, like many other developing countries, had over the years attempted to transform itself from a low technology resource-based economy towards an industrialized economy. Importance of S&T for achieving this transformation had been accepted broadly by the successive Indian governments. The main objective over the years had been to develop India's S&T capabilities so that it can provide inputs for industrialisation on one hand and contribute towards providing basic minimum needs to its large population on the other. The approach to be followed for the development of S&T, the priorities and thrust areas has had significant changes over the years and had closely followed the economic development plans of the country.

India had articulated a planned economic growth since independence, resulting in ten five year plans starting from 1951. Each plan period provided outlays for expenditures to be undertaken for S&T in the country. Broadly, the development of S&T in India can be distinguished under four distinct phases (Ashok et al., 1999): (a) Infrastructure building phase (1947-1960s), (b) Assessment and reorientation phase (1960-1980s), (c) Accountability and performance phase (1980 – 1990s) (d) liberalization phase (1990- onwards). The four phases incorporate the ten plan periods and two annual plans. Table A1-1 highlights the important changes in the S&T plans and priorities in different plan periods.

**Table A1-1: S&T Planning in India**

- The **First Five Year Plan (1951-56)**, gave importance to the establishment of infrastructure for science and technology. As a result of this plan a chain of national laboratories and research institutions were established in different parts of the country. In addition to the objectives of the first plan, the efforts were directed in the **Second Five Year Plan (1956-61)** to strengthen the existing research facilities, coordinate research between agencies, create adequate S&T manpower, link research work at national level with regional/state levels and utilize and reward S&T manpower. Scientific Advisory Committee to Cabinet (SACC) was established in 1958. University Grants Commission was set up in 1953 to

## Organizational Structure of the S&T System in India

India has a complex and multi-layered system of science and science administration consisting of: governmental agencies, autonomous institutions, university system, and industrial R&D, both in the public & private sector.  Broadly, S&T system in India can be classified under the following structures: Central (federal) Government S&T departments/agencies, State (provincial) Government S&T departments, Central Socio-economic ministries, In-house R&D in private industry, S&T in non-governmental organisations (NGOs), and Independent research institutes.

Central government S&T departments/agencies are the main instruments for providing resources, defining priorities, and are responsible for attainments of targets in S&T in different sectors. There are 12 scientific departments/ agencies mainly involved in R&D activity (R&D Statistics, 2000-01, DST) , namely: (1) Department of Science and Technology (DST), (2) Department of Biotechnology (DBT), (3) Department of Atomic Energy (DAE), (4) Department of Space (DOS), (5) Defence Research and Development Organisation (DRDO), (6) Department of Ocean Development (DOD), (7) Department of Scientific and Industrial Research (including CSIR and two public enterprise NRDC and CEL), (8) Indian Council of Agricultural Research (ICAR), (9) Indian Council of Medical Research (ICMR), (10) Ministry of Non-Conventional Energy Sources (MNES), (11) Ministry of Communication & Information Technology (MCIT), and (12) Ministry of Environment & Forest (MEnF).

Five major scientific agencies DRDO, DOS, ICAR, DAE and DSIR (CSIR accounts for majority of funds) alone accounted for  86% of the total R&D expenditure of the central government (1998-99). Further, DRDO received 31.8% of the above share.

The main functions of these agencies are to support and coordinate research in their respective areas. This is carried out through a chain of laboratories/ research institutions under them as well as through research grants/ sponsored projects to higher education sector, national laboratories and establishments. The laboratories under these departments are given in Table A1-2 below:

***Table A1-2: Laboratories under various Scientific Departments***

| Scientific Agency | No. of Institutes |
|---|---|
| Indian Council for Agriculture Research (ICAR) | 84 |
| Defence research & Development Organisation (DRDO) | 53 |
| Council for Scientific & Industrial Research (CSIR) | 38 |
| Indian Council for Medical Research (ICMR) | 27 |
| Department of Science & Technology (DST) | 17 |
| Department of Atomic Energy (DAE) | 14 |
| Department of Electronics (DOE) | 14 |
| Department of Space (DOS) | 8 |
| Department of Biotechnology (DBT) | 5 |

In addition, there are research institutes under other government ministries (steel, power, railways, etc), state public sector industrial in-house R&D units, in-house R&D units of private sector, and universities contributing to research and development. 2899 institutions are estimated to be carrying out R&D activities in India. The summary of number of scientific institutions under different agencies/ministries is given in Table A1-3 below.

**Table A1-3: Scientific Institutions under Different Agencies/Ministries**

| Type of agency/ministry | No. of scientific institutions |
|---|---|
| Central Government: R&D Institutions/laboratories | 545* |
| State Government: R&D Institutions/Joint Sector Companies/ Research Stations | 777 |
| Universities (including 39 Deemed Universities; 11 Institutions of national importance) | 226 |
| In-house R&D units of Private Sector and Non-Profit Research Institutions | 1351 |
| **Total** | **2899** |

Source: S&T Data Book, 2000

*This includes 285 laboratories under the 12 scientific departments

Programmes and Policies of Scientific Departments/Agencies[1]

Department of Space

The primary mission of this department is towards building state-of-the art satellite systems, launch vehicles and associated ground segment configured for application related to the management of land and ocean resources, satellite communication and meteorology. The major mission mode programme includes: operationalisation of NNRMS (National Resource Management System)[2], technology development for future generation of launch vehicles, development of all weather remote sensing technology, and application of space technology in communication, education and health.

Department of Atomic Energy

The main aim of this department is pursuing R&D activities related to nuclear energy and its application. The nuclear power programme involves a long-term strategy for exploiting the vast reserves of thorium in the country. The department in a phased manner has been developing reactors that have higher performance standards and are capable of using thorium as nuclear fuel. Spin off technologies covering applications in health care, agriculture, food preservation, industry and research has been successfully developed and transferred to industry. The important mission mode programmes are related to the development of technology for utilisation of thorium, water desalination, nuclear medicine, and application of irradiation technology for farm products.

Department of Ocean Science

Mission mode programmes of this department include: (i) large scale technology demonstration of Ocean Thermal Energy Conservation (OTEC) plant (ii) studies on technology and development of gas hydrates (iii) ocean information system aimed at generation, analysis, modelling, product development and dissemination of ocean data and data products to users, and (iv) technology development and demonstration of drugs from the sea.

Department of Biotechnology

[1] Plan documents, Annual Reports of scientific agencies

[2] NNRMS is based on data captured from Indian Remote Sensing Satellites on natural resources: wasteland development, characterisation of bio-diversity, landslide management, etc.

Mission mode programme of this department is in the area of genomics, development of new drugs and molecules from important medicinal plants, demonstration and development of biofuels, development of new generation vaccines.
To promote public-private partnership, the Department of Biotechnology (DBT) promoted the Biotech Consortium of India Limited (BCIL) in 1990 with a core capital of Rs. 5.37 crore. The contributors to this fund include financial institutions, public and private limited companies and venture capital funding. The BCIL has a membership of 232 industries and R&D institutions.

Department of Science and Technology

DST programmes cover the following domains: Scientific research support to different scientific disciplines, International scientific cooperation, Societal programmes, Infrastructure development programme, Technology Development, S&T Manpower Development and Promotion, S&T for Women, Management Information System, Meteorology mapping and survey, support to scientific/engineering academies.

The Department has set up Sophisticated Analytical Instrument Facilities (SAIFs) in different parts of the country to provide the facilities of sophisticated analytical instruments to the research workers in general and especially from the institutions, which do not have access to such instruments to enable them to pursue R&D activities. At present, 13 Sophisticated Analytical Instrument Facilities (SAIFs) have been created in selected universities and research institutes across the country covering different disciplines (2003-04 Annual Report DST).

"FIST - Fund for improvement of S&T infrastructure" in universities and higher educational institutions scheme was launched by DST in 2000-2001. Under this scheme, financial supports have been provided to various university departments and colleges for creating basic infrastructure and enabling facilities for promoting high quality teaching and R&D in new and emerging areas. Since inception of the scheme, more than 600 departments in over 189 academic institutions have been identified and supported at a total outlay of about Rs 291 crores for 5 years (2003-04 Annual Report DST).

Apart from the above two programmes, DST has a number of other programmes for strengthening the R&D activity in the country. It has specialised programmes for drug research and development, in advanced materials (mainly in nanomaterials), climate studies, etc. The DST provides funds to various academic institutions through extramural funding under each programme. The details of extramural funding, etc are elaborated later in the R&D expenditure section.

Department of Scientific and Industrial Research (DSIR) including Council of Scientific and Industrial Research (CSIR)

The plans and programmes relating to scientific and industrial research are implemented by the DSIR and CSIR. The DSIR is concerned with the promotion of industrial R&D, development of new technologies and processes, acquisition, management and export of technology and development of consultancy capabilities. DSIR has an ongoing programme for recognition of in-house R&D centers of industrial entities. The recognised centers can avail fiscal and non-fiscal incentives for further development of R&D. Transfer of technology from research institutes, facilitating patenting activity, providing startup capital for commercialisation of indigenous technologies and other related activities are taken up by NRDC (National Research and Development Corporation), autonomous institute under DSIR. CEL (Central Electronics Limited) another autonomous institute under DSIR is involved in developing communication devices, solar cells, etc.

CSIR (with a chain of 38 laboratories) undertakes industrial research covering different sectors of the economy. CSIR’s mission is to provide scientific industrial R&D to maximise economic, environmental and social benefits. CSIR has generated number of technologies mainly through in-house R&D work. CSIR is providing a platform for Indian industry in their foray in developing leading edge technology. CSIR is making vigorous efforts to patent its technologies.

New Millennium Technology Leadership (NIMITLI) has been initiated by CSIR to bring different actors in the innovation chain (R&D organisations, universities, private industry) in a common platform for joint technology development. Technological projects have been mounted in different application areas.

## Expenditure on S&T

The main source of funds for S&T comes from plan outlay in each plan period. The plan outlay is done for different sectors of the economy covering the entire plan period. Further delineations for each subhead within a sector is done from the total allotted fund for a sector. Thus for S&T sector, a total allotment is done and further allotments are done for each of the central S&T departments/scientific agencies. Separate S&T plan allotment is done for each state under state plan. Table A1-4 shows the outlays in the different plan periods for S&T.

**Table A1-4: A Plan-wise Outlay in S &T**

| **Plan** | **Outlay** Rs .Crore* |
|---|---|
| 1st Plan (1951-56) | 4.61 |
| 2nd Plan (1956-61) | 47.0@ |
| 3rd Plan (1961-66) | 71.6 |
| Annual Plan (1966-69) | 47.1 |
| 4th Plan (1969-74) | 130.8 |
| 5th Plan (1974-79) | 388.85* |
| 6th Plan (1980-85) | 1020.24 |
| 7th Plan (1985-90) | 3023.9 |
| Annual Plan (1990-92) | 1620.4 |
| 8th Plan (1992-97) | 9041.7 |
| 9th Plan (1997-02) | 18458.0 |
| 10th Plan (2002-07) | 25243.00 |

These were the funds yearmarked for each plan period under S&T. There are additional supplementary grants and extramural fundings that are discussed later.

*Rs 1 Crore = Rs 10.0 Million

45Rs ≈ 1 US Dollar

Rs 45 Crore ≈ 1 Million US$

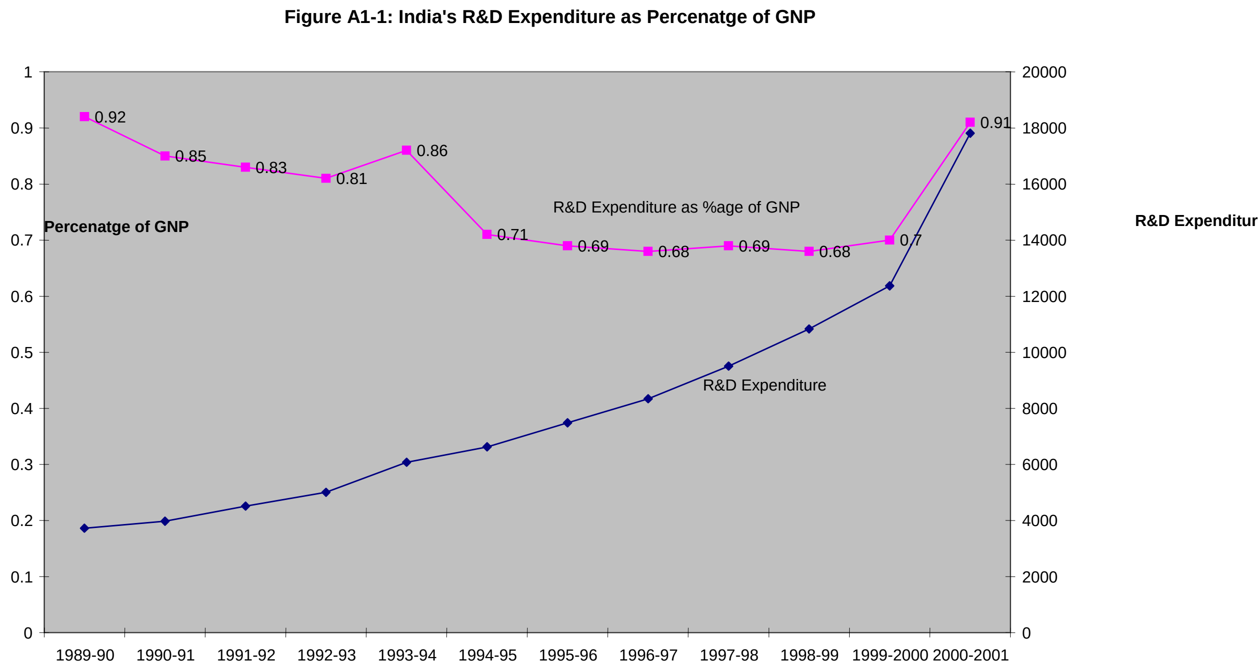
@ Excluding Agricultural Research, Medical Research and other Scientific Ministries

*Excluding National Test House & Environment figure (PC, GoI)

The actual expenditure for S&T departments in each financial year is generally much higher then the plan outlay. The source of funds for additional financial resource is mainly approved under non-plan expenditure. This additional expenditure is approved keeping in view the different constraints and also to provide thrusts to certain programmes. Funds are also obtained through extramural funding (sponsored projects). In majority of the cases universities are the major beneficiaries of extramural funding.

Figure A1-1 - Depicts the R&D expenditure as percentage of GNP from 1989-90 to 2000-01.

Figure A1-1: India's R&D Expenditure as Percentage of GNP




provison figures: for years 1998-99 to 2000-01

Source: CAG Report 5, 2002 (Statstics provided by DST and Central Statistical Organisation)

Figure A1-1 brings out the fact that R&D expenditure as percentage of GNP is still below 1% of GNP. R&D expenditure by different sectors is shown in Table A1-5. Figure A1-2 shows the percentage distribution of funds in different sectors for the financial year 1997-98.

Table A1-5: National Expenditure on Research and Development by Sector

(Rs. In Crore)

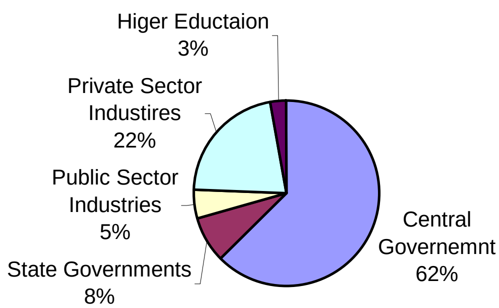
| Sector | 1997-98 | 1998-99 | 1999-00* | 2000-01* |
|---|---|---|---|---|
| Central Sector* | 6884.80 | 8706.03 | 10150.99 | 11835.76 |
| State Sector | 926.76 | 1026.54 | 1177.46 | 1350.56 |
| Private Sector | 2438.25 | 2790.41 | 3365.38 | 4058.83 |
| Higher Education Sector | 361.53 | 378.56 | 396.39 | 415.06 |

| | | | | |
|---|---|---|---|---|
| **Total** | **10611.34** | **12901.54** | **15090.22** | **17660.21** |

R&D Statistics 2000-01 (DST)

*Central Sector comprises of Central Government Agencies and government public sector industries

**Figure A1-2: National R&D Expenditure by Sector 1998-99**




It can be observed from Table A1-5 and Figure A1-2 that majority of the investment in R&D is by the government; accounting for approximately 75% of the total investment in each financial year. Investment by private industry in R&D was only 0.78 % of sales turnover in 1998-99 (based on the estimate of approx. 1200 private firms who have reported investment in R&D). It has been estimated that it is still below 1% of the sales turnover. Only in some industry such as pharmaceutical industry, it is now above 1% of total sales turnover.

Table A1-6 exhibits expenditure on R&D by field of science.

**Table A1-6: Expenditure on Research and development by Field of Science (1998-99)**

(Rs. Lakhs)*

| Field Of Science | Central Government | State Government | Public Sector | Private Sector | Total |
|---|---|---|---|---|---|
| Natural sciences | 208890.77 (26%) | 3530.45 (3%) | 11480.54 (18%) | 32988.14 (15%) | 256889.9 (21%) |
| Engineering & Technology | 474225.85 (59%) | 4725.51 (5%) | 52541.39 (81%) | 72378.95 (32%) | 603871.7 (50%) |
| Medical Sciences | 29694.10 (4%) | 2874.15 (3%) | 1079.44 (2%) | 63512.86 (28%) | 97160.55 (8%) |
| Agricultural | 92689.82 | 91523.55 | 0 | 56468.07 | 240681.44 |

| | | | | | |
|---|---|---|---|---|---|
| sciences | (8%) | (90%) | | (25%) | (20%) |
| **Total** | **805500.54** | **102653.66** | **65101.37** | **225348.02** | **1198603.59** |

Note: *1 lakh=0.1Million Source: Constructed from DST R&D (2000-01)
Percentages are relative to the total expenditure statistics 2000-01 in each sector. All percentages are rounded off.

It is striking to note the low levels of investment in medical science by the all the different types of entities. Different priorities can be observed in terms of funding in Engineering & Technology and Agricultural Sciences by central and state government.
Actual expenditure by ministries/departments, as elaborated earlier, includes apart from plan expenditure, non-plan expenditure and extramural funding. Thus it is useful to observe the actual expenditure in each department to obtain proper assessment of research funding. The latest expenditure details are available from Comptroller and Auditor General Report (CAG Report 2005). Table 7 show the expenditure of Scientific departments/organisations covered by this report.

**Table A1-7: Expenditure of Scientific Departments/Major Scientific Organisations**

(**Rs in crore)**

| **S.No** | **Ministry/Department/Organisation** | **2002-03** | **2003-04** |
|---|---|---|---|
| 1 | Department of Atomic Energy | 6018.73 | 6148.41 |
| 2 | Department of Space | 2162.22 | 2268.80 |
| 3. | Indian Council of Agricultural Research | 1333.96 | 1464.17 |
| 4 | Department of Scientific and Industrial Research (including grants given to Council of Scientific and Industrial Research) | 936.71 | 1090.09 |
| 5. | Environment and Forests, including Zoological Survey of India and Botanical Survey of India | 1057.52 | 1036.19 |
| 6 | Department of Science and Technology including Survey of India and India Metrological Department | 920.84 | 985.84 |
| 7 | Information Technology | 497.34 | 530.62 |
| 8 | Ministry of Non-Conventional Energy sources | 428.33 | 381.33 |
| 9 | Geological Survey of India (Ministry of Mines)* | 248.31 | 271.60 |
| 10 | Department of Biotechnology | 220.70 | 262.55 |
| 11 | Indian Council of Medical Research | 180.00 | 201.86 |
| 12 | Department of Ocean Development | 167.05 | 169.50 |
| 13 | Centre for Development of Telemetics (Department of Telecommunications)* | 108.80 | 47.66 |

Source: CAG Report: Report No. 5 of 2005 (Scientific Departments)

*These two departments do not figure in the list of DST major scientific agencies

It can be observed from Table A1-7, high level of funding for the Department of Atomic Energy in comparison to other scientific agencies. It should be noted that the report covers the autonomous departments/organisations audited by the CAG. DRDO attracts a very high degree of funding by the government. However, their expenditure statement is not provided by CAG.

Table A1-8 shows the extramural funding by different departments.

**Table A1-8: Agency wise support to extramural (sponsored) R&D projects approved during 2002-03**

| S.No | Department/Ministry/Agency | No. of Projects | | Total Approved Cost | |
|---|---|---|---|---|---|
| | | No. | %age | Rs (Lakhs) | %age |
| 1 | All India Council for Technical Education (AICTE) | 211 | 7.76 | 1757.36 | 3.92 |
| 2 | Council of Scientific and Industrial Research (CSIR) | 304 | 11.18 | 2416.82 | 5.39 |
| 3 | Defence Research and Development Organisation (DRDO) | 103 | 3.79 | 2258.12 | 5.03 |
| 4 | Department of Atomic Energy (DAE) | 104 | 3.83 | 1708.48 | 3.81 |
| 5 | Department of Biotechnology (DBT) | 124 | 4.56 | 4138.14 | 9.22 |
| 6 | Department of Coal (DOC) | 10 | 0.37 | 616.07 | 1.37 |
| 7 | Department of Ocean Development (DOD) | 15 | 0.55 | 1511.13 | 3.37 |
| 8 | Department of Science and Technology (DST) | 813 | 29.91 | 17656.25 | 39.35 |
| 9 | Department of Scientific and Industrial Research (DSIR) | 14 | 0.52 | 563.32 | 1.26 |
| 10 | Department of Secondary and Higher Education (DOSHE) | 134 | 4.93 | 1168.00 | 2.60 |
| 11 | Indian Council of Agricultural Research (ICAR) | 162 | 5.96 | 2161.98 | 4.82 |
| 12 | Indian Council of Medical Research (ICMR) | 194 | 7.14 | 3615.04 | 8.06 |
| 13 | Indian Space Research Organisation (ISRO) | 43 | 1.58 | 396.98 | 0.88 |
| 14 | Ministry of Communication and IT (MOCIT) | 26 | 0.96 | 1947.04 | 4.34 |
| 15 | Ministry of Environment and Forests | 40 | 1.47 | 527.43 | 1.18 |

| | | | | | |
|---|---|---|---|---|---|
| | (MOEF) | | | | |
| 16 | Ministry of Food Processing Industries (MFPI) | 16 | 0.59 | 552.53 | 1.23 |
| 17 | Ministry of Non-Conventional Energy Sources (MNES) | 21 | 0.77 | 313.28 | 0.70 |
| 18 | Ministry of Social Justice and Empowerment (MOSJE) | 10 | 0.37 | 87.41 | 0.19 |
| 19 | University Grants Commission (UGC) | 374 | 13.76 | 1473.62 | 3.28 |
| | **Total** | **2718** | **100** | **44869.00** | **100** |

Source: Directory of Extramural Research and Development Approved for funding by Selected Central Government Agencies/Departments in 2002-03, DST (2005)

It can be observed from the above table that DST is the major source of extramural funding. Scientific agencies have S&T programmes keeping in view their mandate and missions. Table A1-9 provides details on the programs in each scientific agency under which extramural funds were provided in the year 2002-03.

**Table A1-9: Scheme-wise Support to Extramural R&D Projects Approved During 2002-03**

| S.No | Department/Ministry/Agency | No. of Projects | Total Approved Cost Rs (Lakhs) |
|---|---|---|---|
| **1** | **All India Council for Technical Education (AICTE)** | **211** | **1757.36** |
| | - Research & Development (R&D) | 118 | 753.74 |
| | - Thrust Area Programme in Technical Education (TAPTEC) | 93 | 1003.62 |
| **2** | **Council of Scientific and Industrial Research (CSIR)** | **304** | **2416.82** |
| | - Emeritus Scientist (ES) | 39 | 297.60 |
| | - General Scheme (GS) | 265 | 2119.22 |
| **3** | **Defence Research and Development Organisation (DRDO)** | **103** | **2258.12** |
| | - Aeronautical Research & Development Board(ARDB) | 39 | 272.61 |
| | - Grants-in-Aid Scheme (GS) | 64 | 1985.51 |
| **4** | **Department of Atomic Energy (DAE)** | **104** | **1708.48** |
| | - Board of Research in Nuclear Sciences (BRNS) | 104 | 1708.48 |
| **5** | **Department of Biotechnology (DBT)** | **124** | **4138.14** |
| | -Research & Development (R&D) | 124 | 4138.14 |
| **6** | **Department of Coal (DOC)** | **10** | **616.07** |
| | - Science & Technology (S&T) | 10 | 616.07 |
| **7** | **Department of Ocean Development (DOD)** | **15** | **1511.13** |
| | -Marine Research Development Fund (MRDF) | 15 | 1511.13 |
| **8** | **Department of Science and Technology (DST)** | **813** | **17656.25** |
| | -Deep Continental studies (DCS) | 17 | 169.44 |
| | - Drugs & Pharmaceutical Research Programme | 8 | 672.05 |
| | (DPRP) | 7 | 194.62 |
| | - Himalayan Glaciology (HG) | 12 | 198.49 |
| | - Indian Climate Research Programme (ICRP) | 17 | 250.65 |
| | - Instrument Development programme (IDP) | 8 | 5149.75 |
| | - Intensification of Research in High Priority | | |

| | | | |
|---|---|---|---|
| | Areas (IRHPA) | 47 | 245.77 |
| | - International Division (ID) | 10 | 377.22 |
| | - Joint Technology Programme (JTP) | 4 | 31.91 |
| | - Monsoon and Tropical Climate Studies (MONTCLIM) | 24 | 403.73 |
| | - Natural Resources Data Management System (NRDMS) | 239 | 3892.14 |
| | - Science and Engineering Research Council (SERC) | 91 | 1301.89 |
| | - Science and Engineering Research Council- Engineering Projects (SERC EP) | | |
| | - | 24 | 1397.65 |
| | - Science and Engineering Research Council – Nanomaterials science & Technology Initiative (SERC NSTI) | 202 | 1687.89 |
| | - Science and Engineering Research Council- Fast Track (SERC FT) | 36 | 405.38 |
| | - Science and Engineering Research Council_project Advisory (SERC PAC) | 35 | 916.28 |
| | - Seismicity Programme (SP) | 3 | 9.96 |
| | - State Science & Technology Pogramme | 13 | 271.78 |
| | (SST) | 10 | 35.81 |
| | - Technology System Programme (TSP) | | |
| | - Utilisation of Scientific Expertise of Retired Scientists (USERS) | 6 | 43.84 |
| | - Young Scientist Scheme (YSS) | | |
| **9** | **Department of Scientific and Industrial Research (DSIR)** | **14** | **563.32** |
| | - Technology Development & Demonstration Programme (TDDP) | 14 | 563.32 |
| **10** | **Department of Secondary and Higher Education (DOSHE)** | **134** | **1168.00** |
| | - Research and Development (R&D) | 134 | 1168.00 |
| **11** | **Indian Council of Agricultural Research (ICAR)** | **162** | **2161.98** |
| | - Adhoc Research Scheme (ADHOC) | 77 | 1001.13 |
| | - Agriculture Produce Cess Fund (APCF) | 56 | 768.83 |
| | - Agronomy (AGRONOMY) | 12 | 178.31 |
| | - Soil Sciences (SS) | 8 | 92.18 |
| | - Water Management (WM) | 9 | 121.53 |
| **12** | **Indian Council of Medical Research (ICMR)** | **194** | **3615.04** |
| | - Ad-hoc (ADHOC) | 114 | 1598.97 |
| | - Task Force (TF) | 80 | 2016.07 |
| **13** | **Indian Space Research Organisation (ISRO)** | **43** | **396.98** |
| | - Research Sponsored (RESPOND) | 38 | 309.36 |
| | - Space Science Promotion (SSP) | 5 | 87.62 |
| **14** | **Ministry of Communication and IT (MOCIT)** | **26** | **1947.04** |
| | - Research & Development (R&D) | 26 | 1947.04 |
| **15** | **Ministry of Environment and Forests (MOEF)** | **40** | **527.43** |
| | - Conservation and Management of Mangroves (CMM) | 1 | 110.66 |
| | - Coral Reefs (CR) | 3 | 46.00 |
| | - Eastern and Western Ghats (EWG) | 10 | 102.79 |
| | - Ecosystem Research Programme (ERP) | 9 | 79.98 |
| | - Environmental Research Programme | 15 | 169.90 |

| | | | |
|---|---|---|---|
| | (ERP)<br>- Wet Lands (WL) | 2 | 18.10 |
| **16** | **Ministry of Food Processing Industries (MFPI)**<br>- Research and Development (R&D) | **16**<br>16 | **552.53**<br>552.53 |
| **17** | **Ministry of Non-Conventional Energy Sources (MNES)**<br>- Research and Development (R&D) | **21**<br>21 | **313.28**<br>313.28 |
| **18** | **Ministry of Social Justice and Empowerment (MOSJE)**<br>- Science & Technology Mission Modes (S&TM) | **10**<br>10 | **87.41**<br>87.41 |
| **19** | **University Grants Commission (UGC)**<br>- Major Projects (MJRP)<br>- Minor Projects (MNRP) | **374**<br>343<br>31 | **1473.62**<br>1460.91<br>12.71 |
| | **Total** | **2718** | **44869.00** |

Source: Directory of Extramural Research and Development Approved for funding by Selected Central Government Agencies/Departments in 2002-03, DST (2005)

It can be observed from Table A1-9 that different programs under each scientific agency/ministry were involved in extramural funding. From Table A1-8, it was observed that DST was the main provider of extramural funding accounting for almost 30% of extramural funding. From Table A1-9, it can be observed that this funding from DST came from a number of programs it has initiated. Programs were varied in scope and included discipline oriented, women oriented, youth oriented programs. Five programs of DST were observed to provide maximum number of extramural funding namely IRHPA, SERC, SERC FT, SERC NSTI and SERC EP (refer Table above). Some specific discipline oriented programs were observed: DCS, DPRP, SERC NSTI and SP (refer Table above). Indian Council of Agricultural Research and Ministry of Environment and Forests were also observed to have target oriented funding for specific disciplines/area domain. Discipline oriented programs are an indication of the special thrust the government has given towards their development.

Table A1-10 shows the discipline wise extramural funding.

**Table A1-10: Subject Area-wise distribution of Extramural R&D projects and their approved cost during the Year 2002-2003**

(Rs. Crore)

| Subject | No. of Projects | Total Approve Cost | %age of the Total |
|---|---|---|---|
| Agricultural Sciences | 260 | 39.43 | 8.79 |
| Engineering & Technology | 765 | 171.17 | 38.15 |
| Medical Sciences | 397 | 63.21 | 14.09 |
| NATURAL SCIENCES | | | |
| Biological Sciences | 389 | 58.52 | 13.04 |
| Chemical Sciences | 371 | 51.81 | 11.55 |
| Earth Sciences | 241 | 32.83 | 7.32 |
| Mathematics | 45 | 1.95 | 0.43 |
| Physical Sciences | 250 | 29.77 | 6.64 |
| **Total** | **2718** | **2718** | **100** |

Engineering and technology discipline had attracted majority of funding. On the other hand Mathematics attracted least funding.

## Appendix 1 Conclusions

India has established wide-ranging capability and infrastructure in S&T. This massive structure had mixed successes. India had developed many indigenous technologies that led to the circumvention of probative cost (for example development of satellites for various applications, etc) and in many cases overcoming the denial of sophisticated technologies by international firms and countries[3]. This has been particularly so in strategic areas of space, nuclear technology and dual use technologies. Developments of sophisticated parallel super computers, satellite launch vehicles, etc, are some notable successes.

However, the contribution of science and technology has to be seen in a larger context than merely in terms of quantitative parameters such as publications and patents. This is more so in developing countries where funds for basic/applied research are limited. It is important to uncover to what extent science and technology contribute to accelerating growth, removing poverty and ensuring significant improvement in the living standards. In almost all developing countries, most of the contributions towards research funds come from the public exchequer. Hence, the public has to be assured of visible returns from this investment.

[3] India was denied access to high technologies, particularly those that could have possible defence applications, by US and many European countries. For example, India was not allowed to purchase supercomputers for weather forecasting and research as it was argued that they might be used for nuclear applications. Similarly, cryogenic engines were denied for space applications due to the argument that they could be used for development of long range missiles.

In India, government accounts for roughly 75% of the R&D budget. The largest share of the Indian R&D budget goes to strategic sectors such as atomic energy, space, and defence, roughly 52% of the overall government budget. Agriculture or agro-based industries, textiles and garments contribute 45% of India's exports. It should be an important priority for all developing countries such as India to redirect R&D investment into areas that contribute most to national GNP, or to the solution of important social problems.

During the evolution of S&T structure in India, there have been inadequate linkages between S&T and economic activity. R&D has not been mediated by the requirements of the market place. Indian exports today derive their advantage from cheap labour and natural resources. Technology intensive products are 4% to 7% in the overall export basket. Production and marketing sectors have yet to be fully benefited from the R&D services.

Transfer of technology from research organisations to the industry had met with limited success. In spite of successful demonstration at the laboratory level, industry has been sceptical of the viability of the technology at the commercial level. New initiatives are being created to forge partnership with industry through public-private partnership programs.

WTO (World Trade Organisation), of which India is a member country, has created rules and regulations for a multilateral trading system. In this new trading system, domestic firms would have to compete in equal terms with international firms. TRIPS (Trade Related Intellectual Property Rights) agreement in WTO has put protection of intellectual property embedded in trade. Thus, in the changing global scenario, Indian science and technology would have to play the primary role of making Indian industry innovation-driven, as market would become increasingly innovation-driven. On the other hand S&T would have to provide new solutions for improving agricultural productivity, safeguarding environmental degradation, etc.

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Jain, A., Chen, W., Kharbanda, V.P., Nanning, Z., Zhongman, W., Jiyao, C. (1999). A comparative study of science and technology development strategies in India and China. Project Report by National Institute of Science Technology and Development Studies (NISTADS) India and Development Research Centre, Central-south University of Technology (CSUT) China.

# APPENDIX 2 – SELECTED TECHNOLOGY BIBLIOMETRICS

## A2.1. Films

Based on the computational linguistics (document clustering) results, Thin Films is an important area of Indian research. The following simple query (film*) was inserted into the Science Citation Index search engine, and 2000 records were retrieved for the period 2003-2005 (March). The bibliometrics was performed on these retrieved records.

### A2.1.1. Publication Statistics on Authors, Journals, Institutions, Countries

#### A2.1.1.1. Most Prolific Authors

**TABLE A2-1**

| AUTHOR | INSTITUTION | #PAP |
|---|---|---|
| Kumar--A | Ctr Adv Technol | 37 |
| Kumar--S | Christ Church Coll | 35 |
| Sastry--M | Natl Chem Lab | 30 |
| Mangalaraj--D | Bharathiar Univ | 27 |
| Narayandass--SK | Bharathiar Univ | 27 |
| Kumar--R | Univ Delhi | 26 |
| Avasthi--Dk | Nucl Sci Ctr | 25 |
| Chaudhuri--S | Indian Assoc Cultivat Sci | 19 |
| Lokhande--CD | Shivaji Univ | 19 |
| Chatterjee--S | Indian Assoc Cultivat Sci | 18 |
| Das--D | IIT | 18 |
| Krupanidhi--SB | Indian Inst Sci | 18 |
| Sharma--A | Indian Inst Technol | 18 |
| Chattopadhyay--KK | Jadavpur Univ | 17 |
| Banerjee--S | Def Res & Dev Estab | 15 |
| Gupta--A | Inter Univ Consortium Dae Facil | 15 |
| Hundiwale--DG | N Maharashtra Univ | 15 |
| Jayachandran--M | Cent Electrochem Res Inst | 15 |
| Kapadi--UT | N Maharashtra Univ | 15 |
| Sanjeeviraja--C | Alagappa Univ | 15 |

There is a much broader listing of surnames than the three listed for Crops. Twelve are from universities, and eight are from research centers, suggesting again a very applied research focus.

#### A2.1.1.2. Journals Containing Most Papers

## TABLE A2-2

| JOURNAL | #PAP |
|---|---|
| Journal Of Applied Physics | 57 |
| Thin Solid Films | 54 |
| Materials Chemistry And Physics | 49 |
| Materials Letters | 48 |
| Journal Of Applied Polymer Science | 47 |
| Applied Surface Science | 44 |
| Nuclear Instruments & Methods In Physics Research Section B-Beam Interactions With Materials And Ato | 43 |
| Physical Review B | 41 |
| Solar Energy Materials And Solar Cells | 37 |
| Bulletin Of Materials Science | 36 |
| Applied Physics Letters | 32 |
| Indian Journal Of Physics And Proceedings Of The Indian Association For The Cultivation Of Science-P | 29 |
| Materials Science And Engineering B-Solid State Materials For Advanced Technology | 29 |
| Solid State Communications | 25 |
| Journal Of Physics D-Applied Physics | 24 |
| Langmuir | 24 |
| Indian Journal Of Pure & Applied Physics | 24 |
| Journal Of Colloid And Interface Science | 21 |
| Sensors And Actuators B-Chemical | 21 |
| Synthetic Metals | 19 |

Only two of the journals are Indian, and they are lower in the rankings. Most of the journals are applied, confirming the conclusions based on the authors' institutions. The main focus is on physics, with strong emphasis on materials and chemistry as well.

A2.1.1.3. Most Prolific Institutions

## TABLE A2-3

| INSTITUTE | # PAP |
|---|---|
| Indian Inst Technol | 329 |
| Indian Inst Sci | 148 |
| Indian Assoc Cultivat Sci | 106 |
| Natl Phys Lab | 85 |
| Natl Chem Lab | 81 |
| Bhabha Atom Res Ctr | 78 |
| Univ Delhi | 64 |
| Shivaji Univ | 60 |

| | |
|---|---|
| Inst Phys | 60 |
| Indira Gandhi Ctr Atom Res | 56 |
| Alagappa Univ | 45 |
| Tata Inst Fundamental Res | 45 |
| Jadavpur Univ | 44 |
| Ctr Nucl Sci | 43 |
| Cent Electrochem Res Inst | 40 |
| Bharathiar Univ | 37 |
| Cochin Univ Sci & Technol | 35 |
| Solid State Phys Lab | 31 |
| Ctr Adv Technol | 29 |
| Saha Inst Nucl Phys | 27 |
| Anna Univ | 27 |
| Banaras Hindu Univ | 27 |

Ten of the institutions are universities, and the remaining twelve are research centers. This provides further evidence of the applied nature of the work. Curiously, four of the institutions are nuclear/ atom research focused. Since films are surface phenomena, with charged particle and Van Der Waals forces predominating, and EV-level charged particle binding energies, why are organizations focused on nuclear forces and their associated MEV-level nuclear binding energies involved so heavily?

The areas that are receiving attention in nuclear/atomic research laboratories are lasers and accelerators. Fundamental research is being undertaken in the development of new devices. One fundamental research work undertaken is in ‘light emitting properties of semiconductors’. To overcome the problems with doping and establishing a suitable crystalline match-up between the light emiting material and substrate material, research work is undertaken in new epitaxial techniques (in epitaxy very thin layers of different atoms are laid over each other). The target is to develop lasers that can be operated at power levels up to 700 megawatts, at temperatures up to room temperatures, and at duty cycles (fraction of time the laser is on) as high as 40%.

### A2.1.1.4. Most Prolific Countries

## TABLE A2-4

| COUNTRY | # PAP |
|---|---|
| India | 2000 |
| Usa | 101 |
| Germany | 82 |
| Japan | 67 |

| | |
|---|---|
| France | 49 |
| South Korea | 47 |
| Taiwan | 32 |
| England | 27 |
| Italy | 21 |
| Peoples R China | 19 |
| Mexico | 11 |
| Netherlands | 7 |
| Sweden | 7 |
| Canada | 7 |
| Switzerland | 7 |
| Australia | 6 |
| Malaysia | 6 |
| Poland | 5 |
| Brazil | 5 |
| Russia | 5 |
| Singapore | 5 |

Three major collaborators stand out (USA, Germany, and Japan), with the next tier consisting of a balance of advanced Western European countries (France, England, Italy) and rapidly developing Asian countries (South Korea, Taiwan, China).

A2.1.2. Citation Statistics on Authors, Journals, Documents

A2.1.1.2.1. Most Cited First Authors

**TABLE A2-5**

| AUTHOR | # CITES |
|---|---|
| Mott NF | 78 |
| Sastry M | 67 |
| Das D | 58 |
| Chopra KL | 56 |
| Gupta B | 54 |
| Rao CNR | 54 |
| Robertson J | 54 |
| Gole A | 52 |
| Sze SM | 50 |
| Kumar A | 47 |
| Gupta A | 46 |
| Cullity BD | 45 |
| Wei Y | 45 |
| Banerjee S | 42 |
| Jin S | 41 |
| Ghosh S | 41 |

| | |
|---|---|
| Kumar S | 39 |
| Borole DD | 38 |
| Macdiarmid AG | 38 |

### A2.1.1.2.2. Most Cited Journals

## TABLE A2-6

| JOURNAL | # CITES |
|---|---|
| Phys Rev B | 2152 |
| J Appl Phys | 2134 |
| Appl Phys Lett | 1998 |
| Thin Solid Films | 1523 |
| Phys Rev Lett | 1218 |
| J Electrochem Soc | 855 |
| Langmuir | 779 |
| J Am Chem Soc | 677 |
| Synthetic Met | 651 |
| J Appl Polym Sci | 604 |
| Nature | 547 |
| Science | 526 |
| Nucl Instrum Meth B | 493 |
| J Phys Chem B | 492 |
| J Phys Chem-Us | 448 |
| Sensor Actuat B-Chem | 419 |
| Macromolecules | 416 |
| Solid State Commun | 365 |
| Electrochim Acta | 333 |
| J Mater Sci | 320 |

Physics journals, both basic and applied, are the most highly cited, followed by Chemistry journals.

### A2.1.1.2.3. Most Cited Papers

## TABLE A2-7

| DOCUMENT | # CIT | # CIT - SCI |
|---|---|---|
| Jin S, 1994, Science, V264, P413 | 31 | 2257 |
| **Thousandfold Change In Resistivity In Magnetoresistive La-Ca-Mn-O Films** | | |
| Zener C, 1951, Phys Rev, V82, P403 | 29 | 2885 |
| **Interaction Between The D-Shells In The Transition Metals .2. Ferromagnetic Compounds Of Manganese With Perovskite Structure** | | |
| Vonhelmolt R, 1993, Phys Rev Lett, V71, P2331 | 25 | 1994 |

| | | |
|---|---|---|
| **Giant Negative Magnetoresistance In Perovskitelike La2 / 3ba2 / 3mnox Ferromagnetic-Films** | | |
| Millis Aj, 1995, Phys Rev Lett, V74, P5144 | 22 | 1543 |
| **Double Exchange Alone Does Not Explain The Resistivity Of La2-Xsrxmno3** | | |
| Huang Ws, 1986, J Chem Soc Farad T 1, V82, P2385 | 19 | 797 |
| **Polyaniline, A Novel Conducting Polymer - Morphology And Chemistry Of Its Oxidation And Reduction In Aqueous-Electrolytes** | | |
| Paul Ew, 1985, J Phys Chem-Us, V89, P1441 | 19 | 854 |
| **Resistance Of Polyaniline Films As A Function Of Electrochemical Potential And The Fabrication Of Polyaniline-Based Microelectronic Devices** | | |
| Oregan B, 1991, Nature, V353, P737 | 19 | 2167 |
| **A Low-Cost, High-Efficiency Solar-Cell Based On Dye-Sensitized Colloidal Tio2 Films** | | |
| Mott Nf, 1979, Elect Processes Nonc | 18 | >5000 |
| **Electronic Processes In Non-Crystalline Materials** | | |
| Manifacier Jc, 1976, J Phys E Sci Instrum, V9, P1002 | 17 | 607 |
| **Simple Method For Determination Of Optical-Constants N,K And Thickness Of A Weakly Absorbing Thin-Film** | | |
| Parratt Lg, 1954, Phys Rev, V95, P359 | 16 | 1574 |
| **Surface Studies Of Solids By Total Reflection Of X-Rays** | | |
| Urushibara A, 1995, Phys Rev B, V51, P14103 | 16 | 1063 |
| **Insulator-Metal Transition And Giant Magnetoresistance In La2-Xsrxmno3** | | |
| Wei Y, 1989, J Phys Chem-Us, V93, P495 | 16 | 248 |
| **Synthesis And Electrochemistry Of Alkyl Ring-Substituted Polyanilines** | | |
| Chopra Kl, 1983, Thin Solid Films, V102, P1 | 16 | 815 |
| **Transparent Conductors** | | |

The documents are much more recent than those in the Crops example. Nine of the documents are later than 1980, suggesting a much more dynamic research area. The more recent documents seem to focus on film resistance, while the older documents address the more general electronic processes in materials.

## A2.2. Alloys

Based on the computational linguistics (document clustering) results, Alloys is an important area of Indian research. The following simple query (alloy* OR steel OR steels) was inserted into the Science Citation Index search engine, and 1991 records were retrieved for the period 2003-2005 (March). The bibliometrics was performed on these retrieved records.

### A2.2.1. Publication Statistics on Authors, Journals, Institutions, Countries

#### A2.2.1.1. Most Prolific Authors

## TABLE A2-8

| AUTHOR | INSTITUTION | # PAP |
|---|---|---|
| Raj--B | Indira Gandhi Ctr Atom Res | 40 |
| Das--S | Tata Steel | 29 |
| Mannan--SL | Indira Gandhi Ctr Atom Res | 28 |
| Mudali--UK | Indira Gandhi Ctr Atom Res | 28 |
| Chatterjee--S | Bhabha Atom Res Ctr | 27 |
| Kumar--A | Birla Inst Technol | 27 |
| Kumar--S | Indian Inst Sci | 27 |
| Banerjee--S | Bhabha Atom Res Ctr | 25 |
| Balasubramaniam--R | Indian Inst Technol | 21 |
| Dey--GK | Bhabha Atom Res | 21 |
| Gupta--A | Interuniv Consortium | 21 |
| Singh--AK | Def Met Res Lab | 21 |
| Quraishi--MA | Aligarh Muslim Univ | 20 |
| Chattopadhyay--K | Indian Inst Sci | 19 |
| Rao--KBS | Indira Gandhi Ctr Atom Res | 19 |
| Murty--BS | Indian Inst Technol | 18 |
| Prasad--BK | Csir | 18 |
| Basu--B | Indian Inst Technol | 16 |

Six of the eighteen authors are from universities, eleven are from research centers, and one is from industry, suggesting very applied research. Seven of the institutions focus on atomic research, suggesting interest in alloys for use in nuclear systems.

### A2.2.1.2. Journals Containing Most Papers

## TABLE A2-9

| JOURNAL | # PAP |
|---|---|
| Transactions Of The Indian Institute Of Metals | 118 |
| Materials Science And Engineering A-Structural Materials Properties Microstructure And Processing | 115 |
| Materials Science And Technology | 65 |
| Journal Of Alloys And Compounds | 45 |
| Metallurgical And Materials Transactions A-Physical Metallurgy And Materials Science | 43 |
| Journal Of Materials Processing Technology | 42 |
| Acta Materialia | 34 |
| Bulletin Of Materials Science | 31 |
| Scripta Materialia | 31 |
| Journal Of Materials Engineering And Performance | 30 |
| Bulletin Of Electrochemistry | 29 |

| | |
|---|---|
| Engineering Failure Analysis | 28 |
| Isij International | 27 |
| Journal Of Non-Crystalline Solids | 27 |
| Physical Review B | 25 |
| Journal Of Magnetism And Magnetic Materials | 25 |
| Indian Journal Of Chemical Technology | 23 |
| Sadhana-Academy Proceedings In Engineering Sciences | 23 |
| Journal Of Materials Science | 22 |
| Materials Letters | 21 |

Almost all the journals listed are applied. All the top journals focus on materials, and only near the bottom of the list do more fundamental and generic journals appear (e.g., Physical Review, Bulletin of Electrochemistry).

A2.2.1.3. Most Prolific Institutions

**TABLE A2-10**

| INSTITUTION | # PAPERS |
|---|---|
| Indian Inst Technol | 486 |
| Indira Gandhi Ctr Atom Res | 171 |
| Bhabha Atom Res Ctr | 149 |
| Indian Inst Sci | 129 |
| Def Met Res Lab | 93 |
| Natl Met Lab | 86 |
| Chinese Acad Sci | 84 |
| Banaras Hindu Univ | 71 |
| CSIR | 52 |
| Reg Res Lab | 46 |
| Cent Electrochem Res Inst | 45 |
| Natl Inst Technol | 45 |
| Univ Madras | 30 |
| Tata Inst Fundamental Res | 29 |
| Aligarh Muslim Univ | 29 |
| Anna Univ | 28 |
| Tata Steel | 27 |
| Ctr Adv Technol | 24 |
| Jamia Millia Islamia | 24 |
| Reg Engn Coll | 22 |
| Shivaji Univ | 22 |

Out of 21 institutions listed, only seven are universities. This suggests further a very applied focus. Two of the top three institutions are atomic research centers.

### A2.2.1.4. Most Prolific Countries

## TABLE A2-11

| COUNTRY | # PAP |
|---|---|
| India | 1991 |
| Germany | 104 |
| USA | 86 |
| Japan | 57 |
| Peoples R China | 53 |
| England | 32 |
| France | 23 |
| South Korea | 24 |
| Singapore | 12 |
| Canada | 13 |
| Taiwan | 11 |
| Australia | 10 |
| Italy | 8 |
| Belgium | 6 |
| Mexico | 6 |
| Netherlands | 6 |
| Sweden | 6 |
| Switzerland | 7 |
| Poland | 5 |

The major partners are Germany and the USA, in that order. The reasons for the USA ranking second as collaborator (whereas they rank first in the other three research areas studied) are unclear, and require further study. The next tier consists of Japan and China.

### A2.2.2. Citation Statistics on Authors, Journals, and Documents

### A2.2.2.1. Most Cited First Authors

## TABLE A2-12

| AUTHOR | # CIT |
|---|---|
| Prasad Bk | 140 |
| Inoue A | 135 |
| *Astm | 129 |
| Gurrappa I | 102 |
| Quraishi Ma | 86 |
| Mudali Uk | 75 |
| Baligidad Rg | 65 |

| | |
|---|---|
| Kaul Sn | 53 |
| Rao Kbs | 52 |
| Mckamey Cg | 49 |
| Rao Vs | 49 |
| Prasad Yvrk | 45 |
| Das S | 44 |
| Massalski Tb | 44 |
| Kumar A | 42 |
| Gupta M | 38 |
| Mansfeld F | 38 |
| Dieter Ge | 37 |
| Murty Bs | 37 |
| Kumar V | 36 |
| Cullity Bd | 36 |
| Mott Nf | 36 |

### A2.2.2.2. Most Cited Journals

## TABLE A2-13

| JOURNAL | # CITES |
|---|---|
| Phys Rev B | 1325 |
| Mat Sci Eng A-Struct | 832 |
| J Appl Phys | 682 |
| Acta Metall | 668 |
| Wear | 646 |
| Corros Sci | 579 |
| Phys Rev Lett | 564 |
| J Mater Sci | 555 |
| Corrosion | 545 |
| Acta Mater | 473 |
| J Electrochem Soc | 461 |
| Metall Mater Trans A | 426 |
| Metall Trans A | 424 |
| Appl Phys Lett | 423 |
| Scripta Mater | 357 |
| Surf Coat Tech | 349 |
| Mater Sci Tech Ser | 337 |
| J Magn Magn Mater | 304 |
| Isij Int | 287 |
| J Alloy Compd | 286 |

While there are still a relatively large number of materials journals listed as most cited, some physics journals do appear, especially Phys Rev B (the leader), J Appl Phys, and Phys Rev Lett.

## A2.2.2.3. Most Cited Documents

## TABLE A2-14

| DOCUMENT | # CIT | #CIT SCI |
|---|---|---|
| Mckamey Cg, 1991, J Mater Res, V6, P1779 | 15 | 354 |
| **A Review Of Recent Developments In Fe3al-Based Alloys** | | |
| Inoue A, 2000, Acta Mater, V48, P279 | 14 | 529 |
| **Stabilization Of Metallic Supercooled Liquid And Bulk Amorphous Alloys** | | |
| Prasad Yvrk, 1984, Metall Trans A, V15, P1883 | 13 | 153 |
| **Modeling Of Dynamic Material Behavior In Hot Deformation - Forging Of Ti-6242** | | |
| Kubel Ej, 1987, Advan Mater Process, V132, P51 | 12 | 66 |
| **Expanding Horizons For Za Alloys** | | |
| Kale Gb, 1998, J Nucl Mater, V257, P44 | 12 | 17 |
| **Interdiffusion Studies In Titanium 304 Stainless Steel System** | | |
| Muralidharan S, 1995, J Electrochem Soc, V142, P1478 | 11 | 61 |
| **Polyamino-Benzoquinone Polymers - A New Class Of Corrosion-Inhibitors For Mild-Steel** | | |
| Lee Pa, 1985, Rev Mod Phys, V57, P287 | 11 | 2580 |
| **Disordered Electronic Systems** | | |
| Peker A, 1993, Appl Phys Lett, V63, P2342 | 11 | 891 |
| **A Highly Processable Metallic-Glass - Zr41.2ti13.8cu12.5ni10.0be22.5** | | |
| Schmitt G, 1984, Brit Corros J, V19, P165 | 11 | 175 |
| **Application Of Inhibitors For Acid-Media - Report Prepared For The European-Federation-Of-Corrosion Working Party On Inhibitors** | | |
| Rohatgi Pk, 1986, Int Met Rev, V31, P115 | 11 | 270 |
| **Solidification,Structure And Properties Of Cast Metal-Ceramic Particle Composites** | | |
| Thompson Sw, 1990, Metall Trans A, V21, P1493 | 11 | 51 |
| **Continuous Cooling Transformations And Microstructures In A Low-Carbon, High-Strength Low-Alloy Plate Steel** | | |
| Aleman B, 1993, Mater Sci Tech-Lond, V9, P633 | 11 | 36 |
| **Interface Microstructures In-Diffusion Bonding Of Titanium-Alloys To Stainless And Low-Alloy Steels** | | |
| Andersen Ok, 1984, Phys Rev Lett, V53, P2571 | 11 | 1150 |
| **Explicit, 1st-Principles Tight-Binding Theory** | | |

Most of the highly-cited documents are very applied and material specific. They are also much more recent than the most cited Crops papers, all Alloys papers being post-1980, with half being in the 1980s, and the remainder post-1990.

## A2.3. Infectious Diseases

Based on the computational linguistics (document clustering) results, Infectious Diseases is an important area of Indian research. The following query (INFECT* OR TUBERCULOSIS OR HIV OR HEPATITIS OR MALARIA OR HPV OR ROTAVIRUS OR PNEUMON* OR INFLUENZ* OR ((VIRUS* OR VIRAL OR BACTER* OR E-COLI) AND (PATIENT* OR DISEASE* OR ANTIBOD* OR ACUTE OR CHRONIC OR ANTIGEN* OR SERUM OR IGG OR IGM OR IGA))) NOT (PLANT* OR CROP OR CROPS OR FOOD OR RICE OR WHEAT OR CORN OR SORGHUM OR GROUNDNUT OR MAIZE OR SOYBEAN* OR MILLET OR FRUIT OR POTATO OR AGRICULTUR*) was inserted into the Science Citation Index search engine, and 2000 records were retrieved for the period 2003-2005 (March). The bibliometrics was performed on these retrieved records.

### A2.3.1. Publication Statistics on Authors, Journals, Institutions, Countries

#### A2.3.1.1. Most Prolific Authors

**TABLE A2-15**

| AUTHOR | INSTITUTION | # PAP |
|---|---|---|
| Sharma--S | LV Prasad Eye Inst | 48 |
| Kumar--A | Cent Inst Res Goats | 32 |
| Kumar--S | Christian Med Coll & Hosp | 27 |
| Singh--S | Natl Inst Pharmaceut Educ & Res | 27 |
| Kumar--P | Natl Chem Lab | 21 |
| Kumar--R | Sanjay Gandhi Postgrad Inst Med Sci | 21 |
| Narayanan--PR | Tb Res Ctr | 21 |
| Subbarao--SK | Malaria Res Ctr Icmr | 18 |
| Gupta--A | Sanjay Gandhi Postgrad Inst Med Sci | 17 |
| Kumar--V | Indian Council Med Res | 17 |
| Sharma--A | Int Ctr Genet Engn & Biotechnol | 17 |
| Singh--N | Malaria Res Ctr Field Stn | 17 |
| Sharma--M | Postgrad Inst Med Educ & Res | 16 |
| Sharma--SK | Malaria Res Ctr, Field Stn | 16 |
| Singh--M | Indian Inst Technol | 16 |
| Bandyopadhyay--SK | Indian Vet Res Inst | 15 |
| Bhattacharya--SK | Natl Inst Cholera & Enter Dis | 15 |
| Roy--S | Indian Inst Chem Biol | 15 |
| Das--S | Indian Inst Sci | 14 |

Fifteen of the most prolific authors come from research institutions, and only four come from universities, suggesting a very applied focus.

A2.3.1.2. Journals Containing Most Papers

**TABLE A2-16**

| JOURNAL | # PAP |
|---|---|
| Indian Veterinary Journal | 85 |
| Indian Journal Of Medical Research | 69 |
| Indian Journal Of Animal Sciences | 55 |
| International Journal Of Tuberculosis And Lung Disease | 38 |
| Journal Of Clinical Microbiology | 37 |
| Current Science | 36 |
| Bioorganic & Medicinal Chemistry | 29 |
| Journal Of Biological Chemistry | 26 |
| Biochemical And Biophysical Research Communications | 24 |
| Annals Of Tropical Medicine And Parasitology | 24 |
| Neurology India | 21 |
| Tropical Medicine & International Health | 19 |
| National Medical Journal Of India | 18 |
| Journal Of Gastroenterology And Hepatology | 16 |
| Acta Virologica | 16 |
| Veterinary Research Communications | 16 |
| Journal Of Infectious Diseases | 15 |
| Bioorganic & Medicinal Chemistry Letters | 15 |
| Vaccine | 15 |
| American Journal Of Tropical Medicine And Hygiene | 14 |
| Molecular And Cellular Biochemistry | 14 |
| Tropical Doctor | 14 |

The top three journals are Indian, with an emphasis on animal infectious diseases. Fundamental biology and other broader science disciplines are few, and rank lower on the list. None of the major science journals (Science, Nature) or medical journals (JAMA, NEJM, Lancet) are represented on this list. This may not be a matter of concern as research support is being given to target diseases that are prevalent in India. This support is also coming from international bodies such as WHO, Gates Foundation etc. This type of research work may not be international in scope and thus are being addressed in Indian journals.

A2.3.1.3. Most Prolific Institutions

**TABLE A2-17**

| INSTITUTION | # PAP |
|---|---|
| All India Inst Med Sci | 114 |
| Postgrad Inst Med Educ & Res | 98 |
| Indian Inst Sci | 81 |
| Indian Council Med Res | 75 |
| Christian Med Coll & Hosp | 68 |
| Indian Vet Res Inst | 68 |
| Sanjay Gandhi Postgrad Inst Med Sci | 61 |
| Icmr | 58 |
| Cent Drug Res Inst | 50 |
| Univ Delhi | 45 |
| Int Ctr Genet Engn & Biotechnol | 44 |
| Tb Res Ctr | 42 |
| Malaria Res Ctr | 40 |
| Indian Inst Chem Biol | 35 |
| Maulana Azad Med Coll | 32 |
| Natl Inst Cholera & Enter Dis | 31 |
| Natl Inst Virol | 29 |
| Who | 27 |
| Natl Inst Immunol | 26 |
| Johns Hopkins Univ | 26 |

Fifteen institutions are research institutes, and the remaining five are universities. This imbalance suggests extremely applied research.

### A2.3.1.4. Most Prolific Countries

## TABLE A2-18

| COUNTRY | # PAP |
|---|---|
| India | 2000 |
| USA | 186 |
| England | 54 |
| Japan | 26 |
| Germany | 22 |
| France | 17 |
| Switzerland | 17 |
| Australia | 17 |
| Canada | 15 |
| Peoples R China | 14 |
| Netherlands | 13 |
| Thailand | 12 |
| Scotland | 12 |
| Bangladesh | 11 |
| Italy | 11 |

| | |
|---|---|
| Saudi Arabia | 9 |
| South Korea | 9 |
| Singapore | 9 |
| South Africa | 7 |

The USA is by far the leading collaborator, with England constituting the second tier. Japan and Germany are the third tier, well behind the second tier.

A2.3.2. Citation Statistics on Authors, Journals, and Documents

A2.3.2.1. Most Cited First Authors

**TABLE A2-19**

| AUTHOR | # CIT |
|---|---|
| *Who | 382 |
| Sambrook J | 78 |
| Cole ST | 71 |
| Singh N | 65 |
| *Nat Comm Clin Lab | 62 |
| Laemmli UK | 59 |
| Lowry Oh | 58 |
| Ottesen EA | 57 |
| Singh S | 46 |
| Gupta S | 45 |
| Kumar S | 43 |
| Thompson JD | 40 |
| Basak SC | 38 |
| Chadha VK | 37 |
| Panchagnula R | 37 |
| Lightner DV | 36 |
| Sardana S | 35 |
| Banerji D | 34 |
| Randic M | 34 |
| Dye C | 33 |

A2.3.2.2. Most Cited Journals

TABLE A2-20

| JOURNAL | # CIT |
|---|---|
| J Clin Microbiol | 990 |
| P Natl Acad Sci USA | 917 |
| Infect Immun | 914 |

| | |
|---|---|
| J Biol Chem | 895 |
| J Virol | 728 |
| Nature | 669 |
| J Immunol | 642 |
| Lancet | 618 |
| Science | 594 |
| J Infect Dis | 571 |
| Antimicrob Agents Ch | 433 |
| New Engl J Med | 416 |
| Indian J Med Res | 412 |
| Virology | 382 |
| J Bacteriol | 381 |
| Nucleic Acids Res | 330 |
| Am J Trop Med Hyg | 316 |
| Cell | 290 |
| B World Health Organ | 279 |
| J Mol Biol | 279 |

Most of the previous text mining studies of the first author have shown strong overlap between the journals containing the most papers and the most cited journals. In the present case, there is weak overlap, with only five journals (Journal Of Clinical Microbiology, Journal Of Biological Chemistry, Journal Of Infectious Diseases, Indian Journal Of Medical Research, American Journal Of Tropical Medicine And Hygience) being shared by both lists. Many of the journals uniquely contained on the most cited list are fundamental research journals, and more well-known and recognizable basic science and medical journals (Nature, Science, Lancet, NEJM are also contained on the most cited list.

A2.3.2.3. Most Cited Documents

**TABLE A2-21**

| DOCUMENT | # CIT | # CIT SCI |
|---|---|---|
| Laemmli Uk, 1970, Nature, V227, P680 | 56 | >65500 |
| **Cleavage Of Structural Proteins During Assembly Of Head Of Bacteriophage-T4** | | |
| Lowry Oh, 1951, J Biol Chem, V193, P265 | 52 | >65500 |
| **Protein Measurement With The Folin Phenol Reagent** | | |
| Cole St, 1998, Nature, V393, P537 | 51 | 1972 |
| **Deciphering The Biology Of Mycobacterium Tuberculosis From The Complete Genome Sequence** | | |
| Sambrook J, 1989, Mol Cloning Lab Manu | 51 | >75000 |
| **Molecular Cloning Lab Manual** | | |
| Thompson Jd, 1994, Nucleic Acids Res, V22, P4673 | 31 | 15967 |

| | | |
|---|---|---|
| **Clustal-W - Improving The Sensitivity Of Progressive Multiple Sequence Alignment Through Sequence Weighting, Position-Specific Gap Penalties And Weight Matrix Choice** | | |
| Dye C, 1999, Jama-J Am Med Assoc, V282, P677 | 26 | 739 |
| **Global Burden Of Tuberculosis - Estimated Incidence, Prevalence, And Mortality By Country** | | |
| Chomczynski P, 1987, Anal Biochem, V162, P156 | 25 | 54281 |
| **Single-Step Method Of Rna Isolation By Acid Guanidinium Thiocyanate Phenol Chloroform Extraction** | | |
| Bauer Aw, 1966, Am J Clin Pathol, V45, P493 | 23 | 4625 |
| **Antibiotic Susceptibility Testing By A Standardized Single Disk Method** | | |
| Bradford Mm, 1976, Anal Biochem, V72, P248 | 23 | >65500 |
| **Rapid And Sensitive Method For Quantitation Of Microgram Quantities Of Protein Utilizing Principle Of Protein-Dye Binding** | | |
| Towbin H, 1979, P Natl Acad Sci Usa, V76, P4350 | 20 | 47479 |
| **Electrophoretic Transfer Of Proteins From Polyacrylamide Gels To Nitrocellulose Sheets - Procedure And Some Applications** | | |

Half the documents are pre-1980 vintage, and these older documents focus on protein determination and analysis.  Two of the more recent documents focus on tuberculosis, and the others address molecular sub-cell issues.

An interesting pattern has emerged on the most cited documents.  Two of the disciplines analyzed, Crops and Infectious Diseases, represent two different aspects of the Bio category.  The other two disciplines analyzed, Films and Alloys, represent two different aspects of the Physical Sciences category. The most cited documents in the Crops and Infectious Diseases disciplines tend to be quite old, and many of them are classical references with extremely large numbers of citations.  The most cited documents in the Films and Alloys disciplines are of much more recent vintage, suggesting more dynamic research disciplines.

# APPENDIX 3 – PARTITIONAL CLUSTERING METHOD

CLUTO [Karypis, 2004] is a software package that implements various algorithms for clustering low- and high-dimensional datasets and for analyzing the characteristics of the various clusters. CLUTO implements three different classes of clustering algorithms that can operate either directly in the object's feature space or in the object's similarity space. The clustering algorithms provided by CLUTO are based on the partitional, agglomerative, and graph-partitioning paradigms. CLUTO's partitional and agglomerative algorithms are able to find clusters that are primarily globular, whereas its graph-partitioning and some of its agglomerative algorithms are capable of finding transitive clusters.

In this study, documents were clustered using the partitional clustering algorithms provided by CLUTO. Partitional clustering algorithms find the clusters by partitioning the entire document collection into a predetermined number of disjoint sets, each corresponding to a single cluster. This partitioning is achieved by treating the clustering process as an optimization procedure that tries to create high quality clusters according to a particular function that reflects the underlying definition of the "goodness" of the clusters. This function is referred to as the *clustering criterion function.* CLUTO implements seven such criterion functions that measure various aspects of intra-cluster similarity, inter-cluster dissimilarity, and their combinations, and have been shown to produce high-quality clusters in low- and high-dimensional datasets [Zhao and Karypis, 2004].

CLUTO uses two different methods for computing the partitioning clustering solution. The first method computes a *k*-way clustering solution via a sequence of repeated bisections, whereas the second method computes the solution directly (in a fashion similar to traditional *K*-means-based algorithms). These methods are often referred to as *repeated bisecting* and *direct k*-way clustering, respectively. CLUTO computes a direct *k*-way clustering as follows. Initially, a set of *k* objects is selected from the datasets to act as the *seeds* of the *k* clusters. Then, for each object, its similarity to these *k* seeds is computed, and it is assigned to the cluster corresponding to its most similar seed. This forms the initial *k*-way clustering. This clustering is then repeatedly refined so that it optimizes a desired clustering criterion function. This optimization is performed using a randomized incremental optimization algorithm that is greedy in nature, has low computational requirements, and produces high-quality solutions [Zhao and Karypis, 2004]. A *k*-way partitioning via repeated bisections is obtained by recursively applying the above algorithm to compute 2-way clustering (*i.e.*, bisections). Initially, the objects are partitioned into two clusters, then one of these clusters is selected and is further bisected, and so on. This process continues *k* - 1 times, leading to *k* clusters. Each of these bisections is performed so that the resulting two-way clustering solution optimizes a particular criterion function.

The actual documents were represented with the widely-used vector-space model. The various terms present in the documents were used to define a high-dimensional space and each document was considered to be a vector in that space. However, unlike the traditional vector-space representation, which relies entirely on single terms, all consecutive two- and three-word combinations were taken into account, resulting in a representation that is capable of capturing the phrases commonly occurring in the documents. In addition, Porter's stemming algorithm was used to pre-process the various terms of each document prior to obtaining their vector-space representation. The weight of each dimension was computed using the TF-IDF model in which terms that occur many times within a document are given higher weight (TF) and terms that occur across many documents were given lower weight (IDF) [Zhao and Karypis, 2004]. The similarity between two documents was measured using the cosine of their corresponding document vectors.

# APPENDIX 4 – FLAT TAXONOMIES – DETAILED TECHNICAL THRUSTS

The taxonomies for 1991 and 2002 are shown in Figures A4-1 and A4-2. The categories in the taxonomy levels, and the number of documents in each category (shown in parentheses after each category narrative), are described as follows.

## FIGURE A4-1 – 1991 TAXONOMY

| LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 |
|---|---|---|---|
| Applied Physics, Chemical Engineering/Analysis (4309) | Applied Engineering/Physics (3016) | Theoretical and Applied Physics, Dynamics, Information Technology (1894) | Information Technology/ Theoretical Mathematics (492) |
| | | | Applied and Engineering Physics, Fluid Dynamics, Quantum Mechanics, Astronomy (1402) |
| | | Materials Engineering (1122) | Physical Inorganic Chemistry/ Materials Science (989) |
| | | | Thin Films (133) |
| | Applied/Analytical Chemistry, Biochemistry, Kinetics (1293) | Analytical Chemistry, Kinetics (847) | Analytical Chemistry (416) |
| | | | Chemical Kinetics (431) |
| | | Biochemistry (446) | Properties of Biomolecular Complexes (205) |
| | | | Biomolecular Synthesis (241) |
| Biomedical and Environmental Studies (2799) | Biomedical Studies (1641) | Clinical Diagnostic Studies (440) | Studies Involving Short Term/Acute Complications and Diseases (158) |
| | | | Studies Involving Long Term Conditions and Diseases (282) |
| | | Biomedical and Genetic Studies (1201) | Biochemistry and Medical Treatments (728) |
| | | | Immunology, Biomedicine, Genetics (473) |
| | Agriculture and Ecology (1158) | Agronomy and Plant Biology (647) | Botany/Plant Biology (269) |
| | | | Agronomical, Environmental, and Ecological Studies (378) |
| | | | Entomology and New Species Discovery |

| | | | |
|---|---|---|---|
| | | Entomology and Ecology (511) | (173) |
| | | | Environmental/Ecological Studies (338) |

## FIGURE A4-2 – 2002 TAXONOMY

| LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 |
|---|---|---|---|
| Physical and information sciences (2984) | Physical/digital systems and modeling (1913) | Computer science/networks (474) | Artificial intelligence (87) |
| | | | Systems optimization (387) |
| | | Mathematics, physical systems and modeling, engineering science (1439) | Mathematics, energy, and wave modeling (982) |
| | | | Thermo-fluid dynamics science and engineering (457) |
| | Materials science/film properties (1071) | Materials science (858) | Metal/alloy device physics (497) |
| | | | Electrical/magnetic properties of materials (361) |
| | | Film properties (213) | Thin film deposition (158) |
| | | | Film deposition techniques (55) |
| Medical and biological sciences (4515) | Biological/life sciences (3727) | Biomolecular analysis (1000) | Structure of molecular complexes (442) |
| | | | Compounds/compound synthesis (558) |
| | | Animal and earth sciences/botany (2727) | Biochemistry and animal biology studies (1840) |
| | | | Agricultural, environmental, ecological studies (887) |
| | Medical case studies (788) | Female/child case studies (376) | Diseases affecting women and children in India (191) |
| | | | Uncommon disease affecting children (185) |
| | | General patient studies (412) | Clinical studies (303) |
| | | | Infections and treatment (109) |

## 1991 Database

CLUTO divides Level 1 into two categories:

1. **Biomedical and Environmental Studies** - Studies in human health (biomedicine) and the life sciences, including agriculture, ecology, and plant biology (2799)
2. **Applied Physics, Chemical Engineering/Analysis** – Applied and engineering physics and chemistry, including all sub-fields (4309)

CLUTO divides Level 2 into four categories, by dividing each Level 1 category into two sub-categories:

1. Biomedical and Environmental Studies
    1.1. **Biomedical Studies** – Includes technical biomedical and genetic studies as well as clinical diagnostic studies, focusing on disease prevention and treatment (1641)
    1.2. **Agriculture and Ecology** – Studies in plant biology and agronomy as well as ecological concerns in India (1158)
2. Applied Physics, Chemical Engineering/Analysis
    2.1. **Applied Engineering/Physics** – Physics, dynamics, information technology, and materials science studies, emphasizing the development and use of scientific/mathematical models (3016)
    2.2. **Applied/Analytical Chemistry, Biochemistry, Kinetics** – Chemical reactions as well as chemical compositions/stoichiometries of various biochemical complexes (1293)

CLUTO divides Level 3 into eight categories by dividing each Level 2 category into two sub-categories:

1. Biomedical and Environmental Studies
    1.1. Biomedical Studies
        1.1.1. **Clinical Diagnostic Studies** – Clinical case studies involving both short term and long term complications and diseases (440)
        1.1.2. **Biomedical and Genetic Studies** – Properties of cells, proteins, and other biological elements related to genetics, immunology, and various medical treatments (1201)
    1.2. Agriculture and Ecology
        1.2.1. **Agronomy and Plant Biology** – Plant behavior, soil properties, and production techniques in agricultural settings (647)
        1.2.2. **Entomology and Ecology** – Studies involving various species of insects, as well as the interaction of these species and others with their environment (511)
2. Applied Physics, Chemical Engineering/Analysis
    2.1. Applied Engineering/Physics

- 2.1.1. **Theoretical and Applied Physics, Dynamics, Information Technology –** Covers several areas of physics and mathematics, including information technology, fluid dynamics, quantum mechanics, and astronomy, with emphasis on systems modeling (1894)
- 2.1.2. **Materials Engineering –** Material properties and physical chemistry studies, emphasizing thin film deposition (1122)

2.2. Applied/Analytical Chemistry, Biochemistry, Kinetics
- 2.2.1. **Analytical Chemistry, Kinetics –** Chemical reactions and reaction rates (kinetics) as well as compositional determination and analysis (analytical chemistry) (847)
- 2.2.2. **Biochemistry –** Properties of biomolecular complexes as well as processes for synthesizing various compounds (446)

CLUTO divides Level 4 into sixteen categories, by dividing each Level 3 category into two sub-categories:

1. Biomedical and Environmental Studies

1.1. Biomedical Studies

1.1.1. Clinical Diagnostic Studies
- 1.1.1.1. **Studies Involving Short Term/Acute Complications and Diseases –** Short term clinical studies involving lesions, bone fractures, eye complications, and cysts that require more immediate attention [(158)
- 1.1.1.2. **Studies Involving Long Term Conditions and Diseases –** Long term clinical studies focusing on demographic trends of patients afflicted with various diseases (282)

1.1.2. Biomedical and Genetic Studies
- 1.1.2.1. **Biochemistry and Medical Treatments –** Laboratory studies involving experimental drug testing for future clinical applications (728)
- 1.1.2.2. **Immunology, Biomedicine, Genetics –** Interaction of antigens with specific antibodies as well as mechanisms of hereditary transmission (473)

1.2. Agriculture and Ecology

1.2.1. Agronomy and Plant Biology
- 1.2.1.1. **Botany/Plant Biology –** Plants as studied in isolation, focusing on characteristic features and reproduction/growth (269)
- 1.2.1.2. **Agronomical, Environmental, and Ecological Studies –** Plants in agricultural settings, studied as a system in terms of crop yield, irrigative schemes, and seasonal effects (378)

1.2.2. Entomology and Ecology
- 1.2.2.1. **Entomology and New Species Discovery –** Insect studies focusing on primarily insect- but also non-insect species discovery (173)

1.2.2.2. **Environmental/Ecological Studies –** Ecological impacts of altering the environment in India, with emphasis on water supply (338)

2. Applied Physics, Chemical Engineering/Analysis
    2.1. Applied Engineering/Physics
        2.1.1. Theoretical and Applied Physics, Dynamics, Information Technology
            2.1.1.1. **Information Technology/Theoretical Mathematics –** Algorithms, fuzzy logic systems, and various optimization models rooted in theoretical mathematics and applied to information technology (492)
            2.1.1.2. **Applied and Engineering Physics, Fluid Dynamics, Quantum Mechanics, Astronomy –** Energy, fields, and waves in physics applications (1402)
        2.1.2. Materials Engineering
            2.1.2.1. **Physical Inorganic Chemistry/Materials Science –** Physical properties of non-carbon compounds emphasizing thermal, electrical, and magnetic behavior (989)
            2.1.2.2. **Thin Films –** Techniques and precautions necessary in thin film deposition (133)
    2.2. Applied/Analytical Chemistry, Biochemistry, Kinetics
        2.2.1. Analytical Chemistry, Kinetics
            2.2.1.1. **Analytical Chemistry –** Identification of specific atoms/molecules, as well as constituent weight determination (stoichiometry), in chemical reactions (416)
            2.2.1.2. **Chemical Kinetics –** Detailed studies of chemical reactions and of how equilibrium is reached between products and reactants (431)
        2.2.2. Biochemistry
            2.2.2.1. **Properties of Biomolecular Complexes –** Structural, electrical, and magnetic properties of biomolecules and complexes (205)
            2.2.2.2. **Biomolecular Synthesis –** Behavior of various constituent biomolecules involved in compound synthesis (241)

The specific sub-thrusts (elemental clusters) in each of the above categories are listed and summarized later in this Appendix.

## 2002 Database

CLUTO divides Level 1 into two categories:

3. **Physical and information sciences –** System modeling and informatics as well as material properties (2984)
4. **Medical and biological sciences –** Clinical and medical studies, as well as molecular analysis (4515)

CLUTO divides Level 2 into four categories, by dividing each Level 1 category into two sub-categories:

3. Physical and information sciences
    - 3.1. **Physical/digital systems and modeling –** Applications of computer science, physics, and mathematics to systems modeling (1913)
    - 3.2. **Materials science/film properties –** Electric, magnetic, and thermal properties of materials, with emphasis on materials used in thin films (1071)
4. Medical and biological sciences
    - 4.1. **Biological/life sciences –** Biomolecular analysis as well as plant and animal studies (3727)
    - 4.2. **Medical case studies –** Clinical studies involving various infections/diseases (788)

CLUTO divides Level 3 into eight categories by dividing each Level 2 category into two sub-categories:

3. Physical and information sciences
    - 3.1. Physical/digital systems and modeling
        - 3.1.1. **Computer science/networks –** Optimization and modeling of various systems through the use of networks and intelligent algorithms (474)
        - 3.1.2. **Mathematics, physical systems and modeling, and engineering science –** Modeling systems describing mathematical, physical, and engineering phenomena (1439)
    - 3.2. Materials science/film properties
        - 3.2.1. **Materials science –** Thermal, electric, and magnetic physical properties of materials, with emphasis on metals/alloys (858)
        - 3.2.2. **Film properties –** Physical properties, deposition techniques, and various applications of thin films (213)
4. Medical and biological sciences
    - 4.1. Biological/life sciences
        - 4.1.1. **Biomolecular analysis –** Analyses of structural properties and synthesis techniques of molecular compounds and complexes (1000)
        - 4.1.2. **Animal and earth sciences/botany –** Biological studies of animals as well as environmental and agricultural studies (2727)
    - 4.2. Medical case studies
        - 4.2.1. **Female/child case studies –** Medical studies involving less common diseases restricted mainly to women and children (376)

4.2.2. **General patient studies –** Studies covering a broader range of patient groups and focusing on infections and treatment (412)

CLUTO divides Level 4 into sixteen categories, by dividing each Level 3 category into three sub-categories:

3. Physical and information sciences
    3.1. Physical/digital systems and modeling
        3.1.1. Computer science/networks
            3.1.1.1. **Artificial intelligence –** Artificial neural networks and models used in developing intelligent systems (87)
            3.1.1.2. **Systems optimization –** Algorithms, logic, and designs used in the optimization of various systems (387)
        3.1.2. Mathematics, physical systems and modeling, and engineering science
            3.1.2.1. **Mathematics, energy, and wave modeling –** Mathematical and physical models/equations for prediction of various phenomena (982)
            3.1.2.2. **Thermo-fluid dynamics science and engineering –** Heat flow through various materials, particularly composite blends, and resultant expansion/stress/cracking (457)
    3.2. Materials science/film properties
        3.2.1. Materials science
            3.2.1.1. **Metal/alloy device physics and engineering –** Thermal and physical properties as well as engineering applications of metal alloys (497)
            3.2.1.2. **Electrical/magnetic properties of materials –** Electrical and magnetic properties of various materials in terms of dielectric constants, field behavior, and conductivity (361)
        3.2.2. Film properties
            3.2.2.1. **Thin film deposition –** Deposition of thin film layers onto substrates, emphasizing procedure (158)
            3.2.2.2. **Applications of film deposition –** Applications of thin films, including silicon solar cells and use in various high-tech industries (55)
4. Medical and biological sciences
    4.1. Biological/life sciences
        4.1.1. Biomolecular analysis
            4.1.1.1. **Structure of molecular complexes –** Crystallographic and bond structures of complexes and compound molecules (442)
            4.1.1.2. **Compounds/compound synthesis –** Formation of compounds from simpler compounds and elements (558)
        4.1.2. Animal and earth sciences/botany
            4.1.2.1. **Biochemistry and animal biology studies –** Biochemical activity in animals, particularly cellular behavior based on constituent acids/proteins (1840)

4.1.2.2. **Agricultural, environmental, ecological studies –** Effects of soil, climate, and irrigation on plant/crop quality and yield (887)

4.2. Medical case studies

4.2.1. Female/Child case studies

4.2.1.1. **Diseases affecting women and children in India –** Diseases/complications restricted mainly to women and younger populations in India (191)

4.2.1.2. **Uncommon diseases affecting children –** Case studies involving rare diseases, frequently characterized by tumors, lesions, or cysts (185)

4.2.2. General patient studies

4.2.2.1. **Clinical studies –** General patient studies, spanning several months or years, and focusing on broader trends in diseases (303)

4.2.2.2. **Infections and treatment –** Patient studies focusing on specific diseases as well as existing and potential treatments (109)

The specific sub-thrusts (elemental clusters) in each of the above categories are listed and summarized later in this Appendix.

Comparison of 1991 and 2002 Taxonomies

At the highest taxonomy level (Level 1), the ratio of documents in the Physical/ Engineering Sciences to Biomedical/ Environmental Sciences documents reversed from 1991 to 2002. In 1991, the Physical/ Engineering Sciences documents were 61% od the total, whereas in 2002, they were 40% of the total.

Part of this shift was the algorithm's treatment of Biochemistry (a hybrid of Biology [Biomedical] and Chemistry [Physical]). For 1991, the algorithm placed all of chemistry, including biochemistry, in the physical sciences category. This means the link of biochemistry to the chemistry of materials (a more obvious physical sciences area) was stronger than its link to the biology area. For 2002, with more emphasis on the bio component of biochemistry, the link of biochemistry to biological systems was stronger, and biochemistry switched to the biomedical category. Other aspects of chemistry, having close ties to biochemistry through the chemistry route, switched to the biomedical category as well. This example highlights a problem with how inter-disciplinary categories are treated by the present clustering process, and presents the need for an algorithm that allows multiple category assignment of technologies.

## A3-1. 1991 TAXONOMY

The following flat taxonomy can be generated from the Level 4 categories of Figure A3-1. The bullets under each category represent the 256 elemental cluster themes. The parentheses contain the number of records associated with the bullet (cluster).

**DETAILED TECHNICAL THRUSTS**

1. Biomedical and Environmental Studies
   1.1. Biomedical Studies
      1.1.1. Clinical Diagnostic Studies

**1.1.1.1. Studies Involving Short Term/Acute Complications and Diseases**

- (24) [ey 21.6%, complic 5.4%, fistula 3.7%, cataract 2.7%, anterior 2.3%, ulcer 2.1%, intraocular 1.6%, posterior 1.6%, corneal 1.3%, vascular 1.3%] – *Eye complications, particularly in anterior regions but including posterior regions as well, with emphasis on fistulas, cataracts, and ulcers..*
- (30) [fractur 16.9%, bone 11.5%, case 3.6%, injuri 2.4%, nerv 2.1%, skull 1.8%, surgic 1.5%, bilater 1.4%, joint 1.3%, tendon 1.2%] – *Bone fractures resulting from injury, with emphasis on nerve tissue, skull fracture, and surgical procedures..*
- (28) [case 14.2%, abscess 9.0%, rare 7.7%, report.case 2.7%, clinic 2.6%, rare.case 2.6%, report 2.5%, child 1.3%, knowledg 1.2%, congenit 1.1%] – *Rare cases, both clinical and laboratory (rat testing), with emphasis on abscesses and congenital diseases.*
- (20) [syndrom 15.3%, cyst 5.8%, year.old 5.3%, old 4.0%, year 3.8%, case 3.4%, intracrani 2.5%, fever 2.2%, ocular 1.7%, boi 1.7%] – *Various syndromes, particularly those involving cysts, intracranial irregularities, and fever, with emphasis on age-related syndromes.*
- (17) [lesion 26.9%, paranoid 2.5%, dysplasia 2.2%, fast.bacilli 2.2%, acid.fast.bacilli 2.2%, acid.fast 2.1%, leprosi 1.8%, bacilli 1.7%, hpv 1.6%, case 1.2%] – *Lesions, with emphasis on paranoia, dysplasia, and acid-fast bacilli.*
- (15) [aspir 8.6%, cytolog 8.3%, diagnosi 5.4%, case 5.1%, fine.needl 5.0%, needl 4.3%, fine.needl.aspir 4.3%, needl.aspir 4.3%, fna 4.0%, diagnos 3.6%] – *(Fine-needle) aspiration for cytology and diagnosis.*
- (24) [patient 19.5%, cyst 5.3%, biopsi 4.3%, ulcer 3.3%, varic 3.0%, portal 2.8%, esophag 2.3%, needl 1.8%, endoscop 1.6%, sclerotherapi 1.5%] – *Clinical (patient) studies involving cysts, biopsies, ulcers, and varices.*

**1.1.1.2. Studies Involving Long Term Conditions and Diseases**

- (20) [patient 14.5%, vagin 6.6%, cancer 5.9%, ra 4.7%, hysterectomi 2.5%, cancer.patient 2.4%, chromosom 2.4%, flap 2.3%, heteromorph 2.0%, defect 1.7%] – *Clinical (patient) diagnostic studies, particularly involving women, with emphasis on vaginal complications, cancer, and hysterectomies.*

- (35) [patient 29.5%, leprosi 5.9%, nerv 3.0%, month 2.3%, treatment 2.3%, therapi 2.1%, clinic 1.7%, phenytoin 1.4%, cent 1.2%, leprosi.patient 1.2%] *Clinical (patient) studies, particularly longer studies (spanning several months), with emphasis on leprosy, nervous conditions, and associated treatments.*
- (70) [patient 65.2%, diseas 1.0%, month 0.9%, lesion 0.7%, clinic 0.6%, on.patient 0.6%, year 0.5%, two.patient 0.5%, case 0.4%, surgeri 0.4%] – *General clinical (patient) studies, particularly longer studies (spanning several months), with emphasis on diseases involving lesions.*
- (31) [patient 11.0%, group 5.3%, arteri 5.0%, coronari 4.2%, myocardi 3.0%, ventricular 2.6%, left 2.3%, diseas 2.2%, infarct 2.0%, mitral 1.9%] – *Clinical (patient) group studies, with emphasis on arterial, coronary (particularly myocardial), and ventricular complications.*
- (21) [diabet 17.8%, patient 9.4%, cholesterol 2.9%, retinopathi 2.7%, group 1.8%, control 1.6%, stone 1.5%, urinari 1.3%, diabet.patient 1.1%, niddm 1.0%] – *Diabetes in human patients, with emphasis on cholesterol, retinopathy, and urinary problems.*
- (31) [risk 7.6%, group 4.1%, ag 3.9%, women 3.6%, smoke 3.5%, smoker 3.3%, subject 3.2%, diseas 2.4%, preval 1.8%, year 1.4%] – *Group studies involving health risks inherent in cigarette smoking, with emphasis on women of various ages groups.*
- (33) [children 22.5%, ag 5.9%, year 3.8%, diarrhoea 3.0%, consanguin 2.4%, diarrhea 2.1%, or 1.3%, stone 1.2%, control 1.2%, boi 1.2%] – *Illness/disease in children of various age groups, with emphasis on diarrhea and the effects of consanguinity.*
- (18) [month 9.9%, birth 9.0%, ag 7.2%, weight 6.9%, month.ag 6.0%, wean 4.5%, infant 4.1%, birth.weight 2.4%, genet 1.5%, genet.group 1.4%] – *Clinical studies involving very young (infantile) patients, with emphasis on weaning and variance in genetic groups.*
- (23) [femal 15.7%, ag 9.1%, male 5.3%, player 2.1%, sexual 2.1%, vocal 2.0%, girl 1.8%, tma 1.4%, bodi 1.3%, skinfold 1.2%] – *Male/female behavioral comparisons in various environments – as (human) players in athletic matches as well as sexually competitive situations.*

1.1.2. Biomedical and Genetic Studies

**1.1.2.1. Biochemistry and Medical Treatments**

- (34) [cell 28.0%, immobil 6.7%, fragili 1.4%, gill 1.2%, neurosecretori 1.1%, free.cell 1.1%, strain 1.0%, immobil.cell 1.0%, neurosecretori.cell 0.9%, adher 0.9%] – *Cell behavior, with emphasis on immobilization, K. and B. fragilis (bacterial species), and gill filaments (of aquatic animals).*

- (63) [cell 62.2%, protein 1.7%, rna 0.5%, membran 0.5%, dnase 0.4%, starv 0.4%, cell.cell 0.3%, cell.membran 0.2%, tumor 0.2%, surfac 0.2%] – *Cell behavior, with emphasis on proteins, ribonucleic acid (RNA), and membrane properties.*
- (21) [fsh 15.4%, cell 9.4%, matur 4.2%, testosteron 4.1%, prostat 2.9%, inhibin 2.4%, oocyt 2.0%, stain 1.7%, flutamid 1.7%, leydig 1.6%] – *Follicle stimulating hormones (FSH) and their cellular properties, with emphasis on maturity, testosterone, and prostatic conditions.*
- (27) [anim 7.0%, secret 3.9%, immun 3.4%, oestru 2.8%, cycl 2.6%, migrat 2.3%, net 2.0%, respons 2.0%, monkei 1.8%, macrophag 1.4%] – *Animal studies, with emphasis on chemical secretions, immunization, and oestrus cycles.*
- (32) [photoperiod 6.3%, circadian 4.6%, melatonin 4.3%, pineal 4.0%, treatment 3.0%, ovarian 2.6%, inject 2.6%, spawn 2.2%, gland 2.0%, bodi 1.2%] – *Photoperiodic effects, with emphasis on circadian rhythms, melatonin levels (produced by pineal glands), and (chemical) treatment.*
- (29) [drug 37.5%, releas 5.1%, microspher 2.6%, albumin.microspher 1.1%, vitro 0.9%, vivo 0.9%, drug.releas 0.9%, polym 0.8%, rifampin 0.8%, test.drug 0.7%] – *Release properties of drugs, with emphasis on albumin microspheres, and both in vitro and in vivo testing.*
- (19) [liposom 29.1%, mice 2.6%, ascit 2.4%, calcium 2.2%, tumor 2.1%, drug 2.1%, aren 1.7%, eac 1.6%, ehrlich 1.4%, ehrlich.ascit 1.4%] – *Lipsomes, particularly in experimental studies involving mice, with emphasis on the encapsulated drugs, ascites tumors, and calcium levels.*
- (19) [macrophag 13.1%, cytotox 9.3%, cell 7.1%, adr 4.3%, p388 4.1%, tnf 3.0%, activ 1.6%, cisplatin 1.6%, csf 1.5%, cultur 1.4%] – *Macrophages and related cells, particularly addressing responses to cytotoxins, with emphasis on tumor necrosis factor (TNF) activity, cytotoxocity induced by Adramycin (ADR), and cisplatin treatment.*
- (25) [chromosom 48.3%, aberr 2.7%, chromosom.aberr 1.7%, cultur 1.4%, cell 1.3%, sce 1.2%, chromosom.number 1.1%, mitot 1.0%, pesticid 1.0%, chromatid 1.0%] – *Chromosomes, particularly*

*chromosomal aberrations, with emphasis on cellular and culture properties as well as sister chromatid exchanges (SCE).*

- (30) [mice 5.4%, aberr 4.8%, dose 4.0%, clastogen 3.1%, chromosom 2.8%, mutagen 2.7%, chromosom.aberr 2.5%, administ 2.3%, chlorophyllin 2.3%, marrow 2.1%] – *Experiments involving mice, particularly those having (chromosomal) aberrations, with emphasis on treatment dose, clastogenicity, and mutagenic effects.*
- (51) [dose 36.8%, activ 1.4%, dose.depend 1.1%, compound 1.1%, bhc 0.7%, weight 0.7%, mice 0.7%, 100 0.7%, toxic 0.6%, bodi 0.6%] – *Dose-dependent studies, particularly those involving mice, with emphasis on active chemical compounds, such as benzene hexachloride (BHC) (poweful insecticide), and effects on body weight.*
- (24) [receptor 15.9%, memori 5.5%, learn 5.4%, antagonist 4.9%, agonist 4.3%, dose 3.9%, haloperidol 3.4%, retriev 1.9%, 801 1.6%, 920 1.3%] – *Biochemical and physiological receptors, with emphasis on learning and memory, antagonist/agonist activity, and dosage effects of administered drugs.*
- (32) [induc 6.9%, rat 3.0%, inhibit 2.9%, atropin 2.7%, gaba 2.4%, mice 2.3%, antinocicept 2.3%, respons 2.2%, protect 1.5%, gastric 1.2%] – *Induced inhibitory traits, particularly demonstrated through rats or mice, with emphasis on atropine, gamma-aminobutyric acid (GABA), and antinociceptive (analgesic) effects.*
- (22) [muscl 14.1%, tissu 9.3%, kidnei 4.9%, liver 4.1%, liver.kidnei 1.4%, reflex 1.3%, tumour 1.2%, blood 1.0%, phosphat 0.9%, fructos 0.9%] – *Muscles/muscle tissue, as well as tissues of the kidneys and liver, with emphasis on muscle reflexes.*
- (21) [acid 7.9%, phosphatas 4.8%, protein 3.2%, fish 2.7%, exposur 2.5%, subleth 1.9%, mercur.chlorid 1.8%, biochem 1.7%, alkalin.phosphatas 1.7%, acid.alkalin.phosphatas 1.6%] – *Acids, particularly the effects of sublethal acid exposure to animals (e.g. fish), with emphasis on phosphatase activity, proteins, and specifically mercury chloride.*
- (19) [endosulfan 5.6%, dai 3.9%, spermatogenesi 2.6%, lc50 2.5%, testicular 2.2%, accessori.sex 1.9%, sperm 1.9%, accessori 1.8%, fluorid 1.4%, reproduct 1.4%] – *Ongoing effects (over many days) of various chemicals – namely endosulfan (insecticide) and fluoride – on animals, with emphasis on spermatogenesis, testicular reactions, and LC50 (lethal concentration 50) conditions.*

- (18) [insulin 8.0%, rat 6.5%, collagen 3.2%, picroliv 3.0%, dai 2.1%, diabet 2.1%, alloxan 1.9%, glucos 1.8%, nsaid 1.7%, alloxan.diabet 1.7%] – *Insulin delivery for diabetics, particularly through ongoing tests (over many days) on alloxan-diabetic rats, with emphasis on collagen properties and picroliv (irridoid glycoside mixture) activity.*
- (30) [group 13.7%, calv 4.7%, blood 3.1%, bodi 2.3%, glucos 1.4%, sheep 1.4%, feed 1.4%, weight 1.3%, level 1.3%, lead 1.2%] – *Studies involving groups of farm animals, particularly calves and sheep, with emphasis on blood content, body weight, glucose levels, and feeding patterns.*
- (33) [vitamin 13.0%, rat 11.8%, diet 8.9%, protein 2.3%, defici 2.2%, fed 2.1%, supplement 2.1%, weight 1.6%, pup 1.6%, hch 1.2%] – *Vitamin intake, particularly through experimentation on rats, with emphasis on diets (protein content, calories, etc.), deficiencies, and feeding procedures.*
- (26) [cholesterol 29.7%, phospholipid 8.3%, lipid 4.8%, total 1.8%, diet 1.6%, plasma 1.2%, level 1.1%, acid 1.0%, fatti.acid 1.0%, membran 1.0%] – *Cholesterol concentration/levels, as well as lipid (particularly phospholipid) content, with emphasis on total levels of each, relations to diet, and (blood) plasma.*
- (28) [liver 13.3%, lipid 12.4%, peroxid 8.4%, lipid.peroxid 6.3%, rat 2.1%, microsom 2.0%, superoxid 1.9%, antioxid 1.5%, level 1.3%, radic 1.2%] – *Lipids and lipid peroxidation in or around the liver, particularly through studies involving rats, with emphasis on microsome properties, superoxide production, and antioxidative effects.*
- (16) [glutathion 27.0%, gsh 3.3%, glutathion.transferas 3.0%, transferas 2.7%, gst 2.7%, reductas 2.0%, ahh 2.0%, rat 1.2%, glutathion.reductas 1.2%, inhibit 1.2] – *The polypeptide glutathione (GSH), particularly effects of inhibited glutathione-S-transferase (GST) and glutothione reductase, with emphasis on aryl hydrocarbon hydroxylase (AHH) activity as well.*
- (36) [brain 25.9%, respir 4.9%, rat 4.7%, slice 3.4%, activ 2.3%, rat.brain 2.2%, ag 1.2%, liver 1.1%, increas 0.9%, inhibit 0.9%] – *Brain structure (examined by slicing), activity, and content in rats, with emphasis on respiration and effects of aging.*
- (31) [dehydrogenas 14.8%, enzym 9.5%, activ 2.5%, ldh 2.2%, liver 1.3%, testicular 1.2%, inhibit 1.2%, lactat 1.2%, kidnei 1.2%, alp 1.2%] – *Activity of various types of*

*dehydrogenase enzymes, particularly lactic dehydrogenase (LDH), in the liver, kidney, and testicular regions.*

- (42) [enzym 27.7%, activ 10.8%, inhibit 1.8%, enzym.activ 1.6%, substrat 1.5%, isozym 1.4%, mg2 1.4%, subunit 1.2%, purifi 1.1%, esteras 1.1%] – *Enzyme activity/properties, with emphasis on inhibition characteristics, substrate properties, and isozyme behavior.*

**1.1.2.2. Immunology, Biomedicine, Genetics**

- (18) [infect 39.3%, post.infect 4.5%, post 2.4%, week.post 2.3%, week.post.infect 2.3%, pylori 1.5%, cervi 1.3%, dental 1.1%, preval 0.9%, week 0.8%] – *Infections, particularly conditions following onset (in terms of days/weeks post-infection), with emphasis on those affecting the pylori.*
- (19) [viru 23.6%, vaccin 6.3%, virus 4.8%, children 3.9%, antibodi 2.6%, mosaic 2.4%, infect 2.2%, antigen 1.9%, transmit 1.4%, hepat 1.4%] – *Virii and vaccination, particularly in children and plants, with emphasis on antibodies, antigens, and mosaic virii (in plants).*
- (25) [antibodi 15.3%, anti 6.2%, serum 5.2%, sera 5.0%, patient 3.5%, level 1.6%, sampl 1.6%, csf 1.1%, thyroglobulin 1.0%, filari 1.0%] – *Properties of antibodies in patients, with emphasis on serum levels and fluid samples (particularly cerebrospinal fluid, or CSF).*
- (38) [antigen 14.8%, elisa 11.0%, patient 7.9%, antibodi 7.4%, sera 3.6%, assai 3.5%, leprosi 3.4%, tuberculosi 2.1%, detect 1.8%, enzym.link 1.0%] – *Properties of antigens in patients, with emphasis on the ELISA immuno-assay, antibody production, serum (sera) levels, and such diseases as leprosy and tuberculosis.*
- (38) [antibodi 8.6%, sperm 6.8%, antigen 5.7%, spermatozoa 2.4%, protein 2.1%, immun 2.0%, antiserum 2.0%, polypeptid 1.7%, kda 1.5%, epitop 1.4%] – *Antibodies, particularly sperm antibodies, as well as engendering antigens, with emphasis on spermatozoa, protein activity, and immunological properties.*
- (25) [dna 52.5%, hybrid 2.7%, genom 2.0%, sequenc 1.6%, probe 1.1%, cholera 1.0%, clone 1.0%, polymeras 0.9%, fragment 0.8%, tbar 0.6%] – *DNA, with emphasis on hybridization, genomic content/sequence, DNA probes, and cloning.*
- (31) [plasmid 12.7%, gene 10.4%, coli 9.4%, isol 2.0%, clone 1.9%, escherichia 1.6%, escherichia.coli 1.6%, sequenc 1.5%, promot 1.5%, insert 1.4%] – *(DNA) plasmids, particularly those found in Escherichia coli (E.*

*coli) and other bacterial isolates, with emphasis on genetic properties, cloning, and genomic sequence.*

- (20) [strain 38.0%, isol 3.4%, bacteria 1.6%, growth 1.6%, proven 1.2%, azolla 1.1%, ethanol 0.9%, toxigen 0.9%, blight 0.8%, ai 0.8%] – *Strains, particularly isolated bacterial strains, with emphasis on strain growth, provenance, and the aquatic plant Azolla.*
- (20) [mutant 10.0%, uptak 8.1%, glutamin 4.2%, nitrogenas 2.8%, planta 2.8%, glutam 2.4%, mmol 2.2%, strain 2.1%, auxotroph 2.0%, photosynthet 1.7%] – *Mutant strains, with emphasis on uptake activity and behavior of glutamine, nitrogenase, and glutamate, as well as in/ex planta expression.*
- (23) [protoplast 6.2%, growth 5.6%, tube 2.4%, promastigot 2.1%, bacteri 1.9%, regener 1.7%, yeast.extract 1.6%, leach 1.1%, appressoria 1.1%, xanthan 1.1%] – *Growth/regeneration of protoplasts, with emphasis on germ tubes, promastigotes, and bacterial activity.*
- (9) [secretori 19.2%, nectari 9.2%, secretori.zone 3.7%, sub.secretori 3.1%, recess 2.8%, sub.secretori.zone 2.4%, sub 1.6%, wing 1.6%, benzamid 1.6%, alumina 1.6%] – *Secretory and sub-secretory zones, mainly in nectaries.*
- (12) [rna 11.8%, oligonucleotid 9.5%, tubulin 6.0%, beta.tubulin 4.4%, transcript 3.3%, donovani 2.7%, synthesi 2.6%, beta 1.7%, instar 1.4%, group 1.3%] – *Ribonucleic acid (RNA) and oligonucleotides, with emphasis on beta-tubulin genes (and associated transcription) and L. donovani promastigotes.*
- (19) [inhibitor 16.0%, acid 6.4%, amino 3.5%, activ 3.5%, antibacteri 3.1%, trypsin 2.9%, amino.acid 2.0%, chymotrypsin 2.0%, proteas 1.4%, guanidin 1.0%] – *Inhibitors, particularly inhibitor interactivity with (amino) acids, with other emphasis on antibacterial activity and trypsin-inhibiitors and chymotrypsin proteinases.*
- (17) [lectin 30.4%, membran 5.0%, bind 2.6%, site 1.8%, activ 1.7%, agglutin 1.7%, affin 1.6%, bind.site 1.3%, blood.group 1.0%, oxal 0.9%] – *Lectin and its properties, with emphasis on membrane potential, binding sites/affinity, and agglutinating activity.*
- (43) [protein 45.0%, bind 2.6%, 000 0.9%, fraction 0.7%, amino 0.7%, riboflavin.carrier.protein 0.7%, riboflavin.carrier 0.7%, carrier.protein 0.7%, collagen 0.7%, 000.000 0.7%] – *Proteins, with emphasis on binding properties, fractionation, amino acid interactivity, and riboflavin carrier protein.*

- (26) [protein 20.2%, starch 5.3%, content 4.5%, water 2.0%, seed 1.9%, protein.content 1.6%, seed.protein 1.6%, protein.concentr 1.2%, bread 1.0%, solubl 1.0%] – *Protein and starch content in plants and food, with emphasis on seed protein as well as bread making.*
- (38) [digest 12.8%, ferment 4.5%, biomass 3.9%, product 2.5%, bioga 1.9%, litter 1.8%, batch 1.6%, protein 1.4%, lignin 1.2%, acid 1.2%] – *Digestion/digestibility, with emphasis on the effects of fermentation, litter biomass production (as a source of animal feed supplements), biogas production (fuel use), and batch experiments.*
- (26) [product 12.9%, amylas 7.6%, extract 4.7%, ferment 4.5%, bran 2.7%, alpha.amylas 2.3%, enzym.product 1.8%, enzym 1.7%, glucoamylas 1.4%, wheat.bran 1.2%] – *Primarily amylase (enzyme) production, with additional focus on wheat bran fermentation and fluid extraction techniques.*
- (26) [cellulas 12.3%, enzym 11.4%, product 3.9%, ferment 3.4%, cellulos 3.1%, wine 2.2%, xylanas 1.7%, catabolit 1.6%, mutant 1.6%, glucos 1.5%] – *Cellulase enzymes, with emphasis on production and fermentation, cellulose media, and wine (associated fermentation behavior).*

1.2. Agriculture and Ecology

1.2.1. Agronomy and Plant Biology

**1.2.1.1. Botany/Plant Biology**

- (43) [shoot 17.4%, callu 7.4%, cultur 6.3%, medium 6.0%, regener 4.0%, embryo 3.1%, explant 2.5%, plant 2.1%, somat 1.8%, somat.embryo 1.3%] – *(Plant) shoots, with emphasis on callus formation, culture mediums, regeneration, and somatic embryogenesis..*
- (59) [plant 57.3%, leaf 1.3%, growth 0.8%, pathogen 0.8%, sludg 0.7%, cultivar 0.5%, extract 0.4%, shoot 0.4%, tissu.cultur 0.3%, speci 0.3%] – *Plants and their properties, with analysis given to leaves, growth, pathogens, and effects of sludge on growth yield.*
- (32) [plant 8.0%, root 7.4%, nodul 2.5%, nitrogen 1.9%, branch 1.7%, rhizobium 1.6%, salt 1.3%, nitrogenas 1.2%, pulp 1.1%, salt.stress 1.0%] – *Plant studies, with emphasis on roots (and their nodules, typically formed by rhizobia), nitrogen content, branch formation, and salt tolerance.*
- (27) [cultivar 22.7%, leaf 15.9%, fruit 4.9%, resist 2.6%, mildew 1.8%, aba 1.6%, leav 1.4%, infect 1.2%, wax 0.9%, select 0.8%] – *Agronomical cultivars, with emphasis on leaf and fruit properties, resistance (to mildew, rust, infestation), and ABA (abscisic acid) content.*

- (18) [genotyp 16.0%, resist 15.8%, sorghum 5.3%, midg 3.6%, suscept 2.7%, mold 1.8%, borer 1.5%, proven 1.4%, csh 1.4%, grain 1.4%] – *Genotypes, particularly genotypic correlations between factors associated with resistance/susceptibility to sorghum midge, stem borer, and mold damage.*
- (19) [gene 11.1%, cross 8.3%, hybrid 5.4%, resist 4.0%, line 3.2%, trait 3.1%, domin 2.6%, nb18 2.0%, parent 2.0%, cross.hybrid 1.9%] – *(Plant) genes, with emphasis on cross hybridization, resistance to disease, (selective breeding) lines, and dominant traits.*
- (33) [germin 21.1%, seedl 17.0%, pollen 6.3%, seed 4.8%, growth 2.0%, parthenium 1.5%, germin.seedl 1.5%, seedl.growth 1.3%, seed.germin 1.0%, root 0.8%] – *Seed germination, particularly growth of seedlings after pollen-induced fertilization, with emphasis on partheniums.*
- (38) [seed 55.4%, seed.yield 1.8%, plant 1.7%, germin 1.6%, yield 1.6%, cultivar 1.2%, harvest 0.8%, root 0.7%, flower 0.5%, matur 0.5%] – *Seeds and seed yields of various plants (particularly cultivars), with emphasis on germination, maturation, and harvesting.*

**1.2.1.2. Agronomical, Environmental, and Ecological Studies**

- (19) [irrig 33.2%, yield 4.9%, water 3.5%, water.effici 2.0%, seed 1.5%, growth 1.4%, cpe 1.2%, grain 1.2%, grain.yield 1.1%, plant 1.1%] – *Irrigation of seeds and plants, particularly in terms of overall (grain) yield, and with emphasis on water efficiency, growth, and cumulative pan evaporation (CPE).*
- (47) [yield 25.0%, grain 10.5%, grain.yield 5.4%, crop 1.6%, seed 1.4%, applic 1.2%, sow 1.1%, fertil 1.0%, drought 1.0%, manur 0.9%] – *Crop/grain yield, with emphasis on seed properties/treatment, fertilizer application, and sowing.*
- (23) [yield 8.6%, urea 6.0%, dry.matter 5.4%, dry 5.4%, matter 3.8%, superphosph 3.1%, polyphosph 2.4%, grain 2.1%, grain.yield 1.7%, dry.matter.product 1.6%] – *Effects of urea on crop/grain yield, with emphasis on dry-matter production and poly- and superphosphate sources.*
- (20) [rice 20.5%, straw 10.1%, moistur 4.8%, grain 3.3%, wheat 3.1%, kernel 2.9%, paddi 2.2%, crop 1.6%, palat 1.2%, yield 1.1%] – *Grains (wheat, rice, etc.) grown in fields and paddies, emphasizing effects of moisture on crop quality (in terms of yield and palatability).*
- (21) [weed 53.4%, trial 2.3%, control 1.7%, weed.control 1.4%, grass 1.3%, herbicid 1.2%, yield 1.1%, hand.weed 1.1%, crop 0.9%, season 0.9%] – *Weed control, with*

*analyses performed through series of controlled trials, and with emphasis on grass properties, herbicides, and grain yield.*

- (22) [intercrop 25.0%, pigeonpea 8.4%, crop 6.2%, groundnut 4.5%, row 4.2%, maiz 3.6%, yield 2.4%, sole 2.3%, legum 1.8%, intercrop.system 1.8%] – *Intercropping systems – particularly using crops such as pigeonpea, groundnuts, maize, and legumes – with emphasis on row organization and yield.*
- (29) [crop 21.6%, season 3.3%, yield 3.2%, wheat 2.3%, potato 2.2%, pod 1.7%, field 1.5%, sugarcan 1.1%, raini 1.0%, tree 1.0%] – *Crop production, particularly wheat, potatoes, and sugarcane, emphasizing seasonal effects on yield (esp. pod yield) and field fertility.*
- (35) [soil 30.7%, crop 5.5%, applic 4.0%, irrig 3.2%, water 2.7%, fertil 2.1%, wheat 2.0%, gypsum 1.9%, tillag 1.9%, root 1.4%] – *Soil in relation to crop cultivation/tillage, irrigation, and fertilization (esp. gypsum-based).*
- (40) [soil 58.7%, organ 1.4%, forest 0.9%, earthworm 0.9%, dtpa 0.7%, correl 0.5%, extract 0.5%, clai 0.5%, soil.sampl 0.5%, oxid 0.5%] – *Soils, particularly organic and forest soils, with emphasis on earthworm concentration (with correlations to moisture, temperature, pH, etc.) and DTPA- (Dithiophosphoric Acid) extractable forms.*
- (19) [soil 8.8%, insecticid 8.5%, residu 6.8%, hch 5.9%, degrad 4.7%, ddt 4.2%, ddt.hch 1.8%, adapt 1.3%, ddvp 1.3%, bound.residu 1.2%] – *Effects of insecticides (particularly DDT and HCH) on soil properties, emphasizing residues, degradation rates, and adaptability.*
- (20) [ppm 13.3%, fish 5.8%, can 4.6%, bait 3.7%, ddt 3.1%, residu 2.8%, adulter 2.6%, diesel 2.5%, wax 2.5%, fuel 1.9%] – *Fish, particularly in terms of food (quality preservation from canning procedures) and bait, but with additional focus on problems arising from adulteration of water by DDT and other chemicals.*
- (24) [period 14.7%, radon 5.0%, season 2.0%, nighttim 1.5%, summer 1.5%, lactat 1.3%, new.period 1.2%, late 1.2%, delhi 1.1%, winter 1.0%] – *Studies exhibiting some degree of periodicity in India (Dehli), particularly those involving radon levels and seasonal (summer/winter) or day-to-day fluctuations.*
- (21) [milk 15.5%, chees 5.4%, storag 4.3%, fat 2.9%, degre 2.4%, dri 1.8%, carcass 1.6%, product 1.5%, shrimp 1.4%, flour 1.4%] – *Studies involving (primarily)*

*dairy products, mainly milk and cheese, with emphasis on storage temperature, fat content, and drying practices.*

- (38) [oil 62.9%, palm 1.2%, bran 1.0%, essenti.oil 1.0%, crude 0.8%, acid 0.7%, rice.bran 0.6%, groundnut 0.6%, oil.palm 0.6%, fatti 0.6%] – *Oil, particularly crude oil extracted from plants (palm oil, essential oil, rice-bran oil, groundnut oil), with emphasis on fatty acids.*

1.2.2. Entomology and Ecology

**1.2.2.1. Entomology and New Species Discovery**

- (15) [deltamethrin 13.5%, trap 8.4%, moth 8.0%, pest 4.6%, moon 3.7%, catch 3.7%, anthrenu 3.1%, larval 2.3%, armigera 1.9%, trap.catch 1.4%] – *Deltamethrin insecticides as well as trap catches in controlling pests – moths, members of Anthrenus (small beetles), and H. armigera genera – with emphasis on moon phase effects.*
- (25) [larva 23.5%, rear 9.1%, diet 4.1%, food 3.5%, instar 3.4%, larval 2.0%, instar.larva 1.8%, pupa 1.5%, insect 1.4%, parasit 1.3%] – *Insect larva/larva rearing, with emphasis on food/diet, instar stages, pupation, and parasites.*
- (23) [egg 41.8%, lai 1.8%, femal 1.5%, parasit 1.3%, emerg 1.3%, dai 1.2%, mortal 1.2%, adult 1.1%, trichogramma 1.1%, oviposit 1.1%] – *Eggs and egg-laying (female) animals, as well as parasitism and (adult) emergence, with emphasis on developmental cycles (measured in days).*
- (17) [race 18.2%, host 7.4%, parasitoid 6.4%, incognita 5.5%, predat 3.6%, femal 3.5%, reproduct 3.0%, race.incognita 2.8%, host.densiti 2.4%, prei 2.1%] – *Different races (particularly* M. incognita*) of parasitoids and associated hosts, with emphasis on predation, reproduction, and host densities.*
- (36) [speci 46.4%, seagrass 1.5%, two.speci 1.3%, plant 0.8%, gener.name 0.7%, type.speci 0.7%, india 0.6%, restrict 0.5%, name 0.5%, trace 0.4%] – *Broad studies of Indian plant/animal species, with emphasis on seagrasses and related plants.*
- (20) [speci 23.2%, new.speci 23.1%, new 8.9%, genu 4.4%, two.new.speci 3.0%, two.new 2.9%, india 2.1%, kei 2.1%, speci.genu 1.1%, indicu 1.0%] – *Species of plants, animals, and bacteria either newly discovered or new to India, with emphasis on genus (into which the species falls), and with keys typically provided.*
- (17) [taxa 13.0%, new 2.8%, pseudocercospora 2.3%, charophyt 2.1%, lantaden 1.9%, indian 1.8%, lenticel 1.8%, famili 1.8%, genera 1.8%, endem 1.7%] – *Various*

*taxonomic categorizations, or taxa, particularly new families, with emphasis on the pseudocercospora and charophyte taxa, as well as lantadene content (of the lantana plant).*

- (20) [popul 6.4%, speci 4.7%, fungi 4.5%, acph 4.4%, habitat 4.3%, chromosom 3.1%, invers 2.8%, bird 1.4%, indian 1.3%, migrant 1.2%] – *Population studies of various species, particularly fungi, with emphasis on acid phosphatase loci, habitats, and chromosomal analysis.*

**1.2.2.2. Environmental/Ecological Studies**

- (40) [water 32.7%, phytoplankton 3.0%, pond 3.0%, sea.water 1.4%, sea 1.4%, water.vapour 1.1%, site 0.9%, vapour 0.7%, area 0.7%, season 0.7%] – *Properties of natural water sources – ponds, seas, and vapor – as well as phytoplanktonic species living on the water.*
- (31) [pollut 14.8%, effluent 10.2%, station 6.2%, discharg 3.2%, water 3.1%, algal 2.6%, sewag 2.1%, wast 1.9%, river 1.6%, bod 1.3%] – *Water pollution through the discharge of various effluents and waste products, studied at various stations (particularly along rivers), and with emphasis on its effects on algal species.*
- (31) [sediment 47.4%, montmorillonit 1.9%, river 1.9%, sediment.transport 1.8%, transport 1.6%, deposit 1.2%, beach 0.9%, micronodul 0.9%, clai 0.9%, coast 0.8%] – *Sediments and sediment transport, particularly in rivers and along coastlines (beaches), with emphasis on the mineral montmorillonite (a phylosilicate) and micronodules.*
- (17) [basin 22.1%, pebbl 3.9%, crust 3.9%, sediment 2.8%, deposit 2.7%, faci 2.5%, sand 2.3%, anomali 1.5%, continent 1.2%, graviti 1.2%] – *Basins, particularly on geological origins involving gravity and crust activity, with emphasis on pebble, sediment, and sand deposits.*
- (23) [sea 10.5%, detritu 6.1%, arabian 4.6%, arabian.sea 4.2%, microorgan 1.7%, organ.carbon 1.6%, organ 1.5%, marin 1.3%, environ 1.3%, domin 1.3%] – *Marine detritus and microorganisms in the Arabian Sea, with emphasis on organic carbon content, and environmental implications.*
- (22) [monsoon 18.4%, rainfal 14.9%, station 3.0%, monsoon.rainfal 2.7%, year 2.7%, season 1.6%, cycl 1.5%, india 1.5%, period 1.4%, ocean 1.3%] – *Monsoons – particularly the associated rainfall, seasons, and years – with emphasis on number/location of stations as well as periodic/cyclic patterns.*
- (39) [wind 13.8%, layer 3.7%, turbul 2.5%, boundari 2.3%, monsoon 2.3%, surfac 1.9%, mix 1.8%, bubbl 1.7%, upwel 1.3%, boundari.layer 1.3%] – *Wind*

*properties, with emphasis on boundary layer turbelence and surface properties, as well as effects of wind on monsoon circulation.*

- (29) [scintil 9.5%, equatori 5.3%, drift 4.5%, signal 3.1%, irregular 3.0%, ionospher 2.4%, electrojet 2.1%, region 2.0%, solar 1.7%, daytim 1.5%] – *Scintillations, particularly as affected by equatorial conditions (in/near India), with emphasis on drift speed and direction of ionization irregularities, signal behavior, as well as effects contributed by the electrojet and ionosphere.*
- (29) [villag 9.2%, epidemiolog 4.7%, health 4.4%, phage 3.8%, diseas 3.0%, countri 2.1%, drug 1.5%, programm 1.4%, care 1.3%, dust 1.0%] – *Epidemiological studies in (smaller) villages, with emphasis on (bacterio)phages, public health care/implications, disease prevalence, and drug use.*
- (28) [biotechnolog 10.1%, health 7.5%, india 7.2%, popul 4.7%, livestock 4.3%, camel 2.4%, arid 1.9%, countri 1.6%, western 1.1%, ground 1.1%] – *Biotechnology in India, particularly in the health sector, with emphasis on population dynamics, health concerns in livestock (esp. camels), and climatic effects (aridity).*
- (30) [forest 12.5%, land 4.1%, map 3.2%, agricultur 3.2%, farm 2.4%, ir 2.1%, econom 1.3%, remot.sens 1.3%, fuel 1.3%, resourc 1.2%] – *Forests, particularly in terms of land use and agricultural/farming possibilities, with emphasis on mapping techniques, economic implications, and application of IRS (Indian Remote Sensing Satellite) data.*
- (19) [build 7.0%, balloon 3.5%, ir 2.6%, wind 2.2%, resourc 2.1%, built 2.1%, remot.sens 2.1%, climat 1.9%, remot 1.8%, flight 1.8%] – *Primarily buildings and related concerns, such as climatic trends, wind pressure, and energy principles, with secondary focus on scientific balloon technology, emphasizing IRS (Indian Remote Sensing Satellite) data retrieval and resource management.*

2. Applied Physics, Chemical Engineering/Analysis
   2.1. Applied Engineering/Physics
      2.1.1. Theoretical and Applied Physics, Dynamics, Information Technology

**2.1.1.1. Information Technology/Theoretical Mathematics**

- (54) [design 49.7%, optim 8.6%, construct 1.3%, block 1.1%, paper 0.9%, burner 0.7%, class 0.7%, block.design 0.6%, redund 0.6%, system 0.5%] – *Optimization issues inherent in various design problems, particularly in the* *construction of such designs, with emphasis on block designs.*

- (32) [machin 12.4%, system 7.5%, queue 5.5%, model 3.6%, comput 2.0%, stochast 2.0%, paper 1.8%, singl.sampl 1.7%, fm 1.4%, manufactur 1.3%] – *Machine analysis, particularly in complex manufacturing systems, with emphasis on queuing, computing systems, and stochastic modeling.*
- (16) [languag 18.7%, softwar 4.5%, test 3.9%, fdlf 3.0%, system 2.7%, packag 2.7%, decoupl 2.5%, converg 1.9%, bu 1.4%] – *Language issues in software package development, with emphasis on testing systems, particularly the fast decoupled load flow (FDLF) model, which rely on convergence rates.*
- (27) [system 26.6%, oper 2.5%, logic 1.8%, polar 1.2%, integr.system 1.0%, recurs 0.9%, new 0.8%, symmetr 0.8%, probabilist 0.7%, product 0.7%] – *Integrated systems and their operational logic, with emphasis on recursive systems and light polarization analysis.*
- (37) [control 17.9%, system 3.7%, circuit 3.2%, signal 2.5%, bit 2.2%, power.system 2.0%, gener 1.9%, power 1.9%, robust 1.6%, simul 1.3%] – *Control schemes/processes in power systems, with emphasis on circuitry and bit-level digital signal analysis.*
- (32) [imag 30.6%, filter 3.6%, arrai 1.8%, simul 1.8%, digit 1.6%, error 1.6%, algorithm 1.4%, nois 1.3%, paper 1.2%, process 1.2% - *Digital imaging studies, with emphasis on filtering techniques, image arrays, computer simulation, and noise/error reduction.*
- (34) [algorithm 59.4%, graph 5.3%, parallel 0.9%, paper 0.8%, optim 0.8%, time 0.6%, input 0.6%, triangul 0.5%, tree 0.4%, thin.algorithm 0.4%] – *Algorithms, with emphasis on visibility/permutation graphs, parallel execution, time-optimization, and input considerations.*
- (27) [processor 16.1%, algorithm 7.9%, network 7.6%, fault 3.6%, comput 2.5%, parallel 2.2%, constraint 2.0%, system 1.7%, heurist 1.6%, faulti 1.3%] – *Processors in distributed and networked computing environments, with emphasis on algorithm efficiency, fault tolerance, and various system constraints.*
- (28) [unit 15.5%, failur 10.4%, system 4.3%, bound 3.1%, time 2.0%, standbi 2.0%, reliabl 1.7%, failur.rate 1.4%, server 1.2%, supplementari 1.1%] – *Muliple-unit systems, particularly two-unit standby systems, with emphasis on reliability bounds, repair times, and failure rates.*

- (29) [test 17.4%, distribut 12.3%, statist 7.5%, pareto 3.7%, bivari 2.1%, asymptot 1.6%, order.statist 1.4%, paper 1.4%, test.statist 1.4%, sampl 1.3%] – *Test statistics and distribution, with emphasis on bivariate exponentiality, Pareto- and semi-Pareto processes, and asymptotic properties.*
- (35) [estim 56.6%, squar 1.4%, regress 1.2%, squar.error 1.1%, miss 1.1%, unbias 1.0%, varianc 1.0%, asymptot 1.0%, mean.squar.error 0.9%, error 0.9%] – *Estimation techniques (in determining missing values), particularly using mean-squared error estimators, and regression coefficients, with emphasis on unbiased estimators.*
- (29) [sigma 9.9%, class 4.3%, manifold 3.0%, matric 2.6%, equal 2.1%, function 2.0%, new 1.6%, paper 1.6%, let 1.6%, grassmann 1.3%] – *Characteristic classes of functions, particularly those involving Grassman/Kenmotsu manifolds, with emphasis on matrices and domain constraints (equality/inequality).*
- (20) [integ 11.7%, algebra 8.3%, let 6.5%, subgroup 4.4%, finit 3.6%, represent 3.4%, set 2.4%, tripl.dot 2.2%, psi 2.1%, ideal 1.7%] – *Algebraic techniques involving integers/integer sets, with emphasis on finite-dimensional groups and subgroups, and representation schemes.*
- (17) [graph 25.9%, set 16.8%, tile 2.1%, commit 1.6%, subdivis 1.2%, graph.minimum.degre 1.2%, graph.minimum 1.2%, charact 1.1%, minimum.degre 1.0%, vertex 1.0%] – *Graphs and value sets contained, with emphasis on (Penrose) tilings and their subdivisions, commitability, and minimum-degree parameters.*
- (18) [theorem 61.8%, dualiti 1.4%, nondifferenti 1.4%, paper 1.3%, proof 1.2%, program 1.0%, multiobject 1.0%, function 0.7%, paper.proof 0.7%, stronger 0.7%] – *Mathematical theorems and their proofs, particularly duality theorems, with emphasis on nondifferentiable functions and multiobjective programming applications.*
- (34) [topolog 21.8%, space 13.9%, omega 3.5%, paralindelof 2.8%, connect 2.4%, map 2.0%, finsler 2.0%, topolog.group 1.4%, theorem 1.2%, set 1.0%] – *Topological spaces, with emphasis on conditions of paralindelof spaces, connected topological groups, and mapping.*
- (23) [fuzzi 75.3%, set 3.7%, fuzzi.set 3.4%, concept 1.2%, topolog 1.0%, space 1.0%, fuzzi.topolog 0.9%, set.fuzzi 0.8%, concept.fuzzi 0.7%, paper.concept 0.7%] – *Fuzzy sets and related concepts, with emphasis on fuzzy topological spaces.*

**2.1.1.2. Applied and Engineering Physics, Fluid Dynamics, Quantum Mechanics, Astronomy**

- (23) [function 13.0%, polynomi 8.2%, object.paper 3.4%, paper 3.4%, object 3.0%, gener 2.9%, formula 1.9%, trivial 1.9%, class.polynomi 1.7%, gener.function 1.6%] – *Mathematical functions, particularly polynomial functions, with emphasis on finite formulae, non-trivial examples, and generalized functions.*
- (23) [object 25.9%, scienc 4.4%, symbol 1.7%, journal 1.6%, reconstruct 1.5%, match 1.5%, passag.time 1.5%, first.passag.time 1.5%, eia 1.5%, cluster 1.4%] –*Scientific implications of various objects, particularly symbolic objects, with emphasis on journal analysis, 3D reconstruction, and matching processes.*
- (27) [roll 10.5%, yarn 8.8%, modulu 3.4%, anomali 3.0%, plate 2.7%, volcan 1.7%, textur 1.5%, superconform 1.2%, loop 1.0%, ultrason 0.9%] – *Primarily rolling properties of metals, emphasizing shear/bulk modulus, anomalies, and plate properties, and with secondary focus on yarn characteristics, emphasizing texture and loop properties.*
- (10) [inequ 46.9%, polygon 5.5%, guard 3.4%, integr.inequ 2.2%, sequel 2.0%, argument 1.7%, complementar 1.6%, fix.point 1.6%, bessel 1.5%, approxim 1.3%] – *Mathematical inequalities, particularly integral inequalities, with emphasis on polygonal approximation, edge guarding, and sequel analyses.*
- (11) [beam 8.2%, grate 6.1%, rectangular 4.1%, coupl 3.6%, waveguid 2.8%, signal 2.7%, signal.beam 2.2%, slot 2.2%, photorefract 2.1%, numer 1.8%] – *Electromagnetic beams, with emphasis on (index) gratings, rectangular waveguides, coupling, and signal beam gain/amplification.*
- (28) [equat 8.2%, propag 8.0%, nonlinear 4.0%, exact 3.2%, solut 2.5%, waveguid 2.4%, function 2.1%, optic 2.0%, propag.constant 1.9%, exact.solut 1.5%] – *(Primarily nonlinear) equations, with emphasis on propagation constants, exact solutions, and waveguides.*
- (35) [equat 22.4%, solut 9.1%, singular 4.2%, space 2.2%, space.time 2.0%, dirac 1.5%, numer 1.1%, integr 1.0%, initi.condit 0.8%, field 0.8%] – *Mathematical equations and associated solutions, with emphasis on singularity, space-time geometry, Dirac algebra, and numerical computations.*
- (26) [load 11.0%, bear 8.7%, lubric 3.8%, journal 2.8%, shell 2.4%, journal.bear 2.0%, clamp 2.0%, equat 1.8%, reynold 1.4%, half.space 1.3%] – *Loads and loading, with*

*emphasis on bearing/journal conditions, lubrication, and shell geometries.*

- (24) [element 36.0%, ring 5.5%, finit.element 2.6%, matrix 2.1%, finit 1.8%, node 1.1%, regular 1.0%, right.regular.element 1.0%, right.regular 1.0%, regular.element 1.0%] – *Mathematical elements, particularly ring-, matrix-, and finite elements, with emphasis on node count and right regular elements.*
- (26) [lamin 6.5%, ply 5.2%, plate 4.3%, stress 4.2%, shear 3.1%, vibrat 2.5%, displac 1.6%, cross.ply 1.1%, cross 1.1%, theori 1.0%] – *Properties of laminates, with emphasis on ply structure (cross ply/angle ply), shear stress/deformation, and vibration behavior.*
- (34) [cross.section 23.0%, section 19.4%, cross 15.0%, scatter 1.4%, energi 1.2%, state 1.0%, approxim 1.0%, collis 0.9%, differenti.cross 0.9%, differenti.cross.section 0.9%] – *Cross sections (esp. differential cross sections), with emphasis on atomic scattering, energy states, and approximation methods.*
- (15) [aerosol 9.3%, drop 8.6%, droplet 6.9%, size 6.5%, size.distribut 3.5%, impel 3.2%, extinct 1.8%, stratospher 1.6%, particul 1.5%, distribut 1.5%] – *Aerosols, with emphasis on drop/droplet properties and size distribution, impeller speed/location, and extinction profiles.*
- (17) [heat 3.8%, drill 3.6%, heat.exchang 2.5%, annul 2.0%, oper.temperatur 1.9%, open 1.8%, system 1.8%, cycl 1.7%, absorpt 1.7%, econom.heat 1.6%] – *Heat/heat exchange, with emphasis on [heat produced in] drilling operations, annulation, and system operating temperatures.*
- (29) [solar 17.8%, air 4.1%, thermal 3.2%, water 2.6%, climat 2.5%, collector 2.3%, heater 1.5%, air.heater 1.4%, absorb 1.2%, cool 1.2%] – *Solar radiation, with emphasis on solar air heaters, thermal performance, water distillation, and climatic conditions.*
- (32) [heat 22.6%, heat.transfer 4.7%, heat.transfer.coeffici 2.6%, transfer.coeffici 2.4%, wall 2.0%, heat.flux 1.7%, transfer 1.5%, coeffici 1.3%, temperatur 1.2%, bed 1.1%] – *Heat/heat transfer, with emphasis on transfer coefficients, effects of wall interfaces, and heat flux.*
- (35) [pressur 33.1%, flow 6.2%, ga 2.6%, veloc 1.6%, cylind 1.3%, nozzl 1.2%, experiment 0.7%, zeta 0.7%, loop 0.7%, fluid 0.6%] – *Pressures in gas/fluid flows and their relation to velocity in cylindrical media and nozzle flows, especially through experimental data acquisition.*
- (48) [flow 22.2%, solut 4.3%, model 2.5%, numer 2.5%, equat 2.1%, analyt 1.3%, finit 1.2%, discharg 1.1%,

boundari 1.0%, friction 0.9%] – *(Fluid) flow properties, with emphasis on analytical solutions, mathematical models/equations, and numerical studies.*

- (23) [porou 5.0%, flow 4.6%, fluid 3.6%, convect 3.6%, plate 3.5%, viscou 3.1%, veloc 2.6%, free.convect 2.4%, past 1.8%, infinit 1.8%] – *Flow properties in porous media (particularly porous plates), with emphasis on fluid viscosity, free-convection flow, and flow velocity.*
- (24) [veloc 10.8%, newtonian 5.4%, fluid 4.5%, rotat 2.3%, particl 2.2%, power.law 1.4%, non.newtonian 1.4%, drag.coeffici 1.3%, layer 1.3%, motion 1.3%] – *Velocity, particularly fluid- and rotational velocity, in physical systems, with emphasis on Newtonian and non-Newtonian power law fluids, and particle properties (e.g. drag coefficients).*
- (60) [wave 48.8%, propag 3.5%, veloc 1.9%, surfac 1.3%, wave.number 1.2%, shock 0.7%, equat 0.6%, surfac.wave 0.6%, wave.veloc 0.6%, plane 0.4%] – *Properties of waves, particularly surface- and shock waves, emphasizing propagation patterns, wave velocity, and wave number.*
- (29 ) [wave 16.9%, plasma 10.3%, soliton 5.2%, acoust 4.1%, nonlinear 2.8%, ion 2.6%, ion.acoust 2.1%, equat 2.0%, electron 1.9%, propag 1.4%, solitari.wave 1.3%] – *Waves in plasmas, particularly solitons and ion-acoustic waves, with emphasis on nonlinear systems, governing equations, and electron properties.*
- (26) [plasma 22.1%, instabl 5.3%, mode 5.1%, propag 2.3%, stabil 2.2%, forc 1.9%, feedback 1.2%, wave 1.2%, plasmon 1.1%, emiss 1.0%] – *Plasmas, with emphasis on mode stability/instability, propagation [of plasma waves], and effects of applied forces.*
- (30) [field 15.7%, magnet 6.4%, electr 4.3%, magnet.field 3.9%, electr.field 3.0%, anomali 1.6%, equat 1.1%, magnet.anomali 1.0%, current 0.8%, distribut.function 0.8%] – *Electric and magnetic fields, with emphasis on anomalies (esp. magnetic), electrical current, and distribution functions.*
- (47) [magnet 24.5%, magnet.field 18.7%, field 17.8%, instabl 1.5%, gravit 0.8%, spin 0.5%, fluid 0.3%, horizont.magnet 0.3%, temperatur 0.3%, convect.instabl 0.3%] – *Magnetic properties/fields, with emphasis on instability, gravitational effects, and [electron] spin.*
- (31) [magnet 9.0%, field 7.3%, critic 6.1%, critic.current 4.6%, current.densiti 3.4%, critic.current.densiti 3.2%, current 2.9%, field.cool 2.5%, hysteresi 2.4%, cool 1.7%]

*– Magnetic properties/fields, with emphasis on critical current density, field-cooling, and hysteresis.*

- (37) [scale 3.3%, mean.field 3.2%, theori 3.1%, expon 2.7%, spin 2.1%, critic 2.0%, epsilon 2.0%, field 2.0%, model 1.7%, mean 1.6%] – *Mean-field theories, with emphasis on spatial scaling, critical exponent values, and electron spin fluctuation.*
- (39) [theori 19.6%, field 4.1%, field.theori 4.0%, spin 3.1%, relativist 2.5%, string 2.4%, quantum 1.7%, particl 1.6%, state 1.2%, perturb 1.2%] – *Field theories, with emphasis on quantum particle spin behavior, relativistic effects, and string field theory.*
- (24) [oscil 32.0%, harmon 4.7%, anharmon.oscil 3.0%, anharmon 2.9%, quantum 2.9%, harmon.oscil 2.6%, eigenvalu 1.8%, boson 1.3%, potenti 1.1%, perturb 0.7%] *– Oscillations/oscillators, both harmonic and anharmonic, with emphasis on quantum systems, eigenvalues, and oscillator potentials.*
- (24) [potenti 16.7%, cage 3.9%, dyon 3.6%, quantum 3.2%, barrier 3.2%, wkb 2.3%, dyonic 1.5%, time.depend 1.4%, symmetri 1.3%, invari 1.0%] – *Potentials, particularly potential barriers, with emphasis on cage migration, quantum (esp. dyonic) solutions, and Wentzel Kramers Brillouin (WKB) analysis.*
- (20) [scatter 16.8%, mobil 5.8%, positron 3.2%, lattic.temperatur 2.9%, electron 2.5%, elast.scatter 1.6%, impur 1.3%, ioniz.impur 1.2%, lattic 1.0%, ioniz 1.0%] – *Particle scattering, with emphasis on [electron] mobility, positron formation, and lattice temperature.*
- (34) [liquid 8.6%, correl.function 5.9%, relax 3.4%, correl 3.4%, theori 3.2%, function 2.5%, dynam 2.3%, liquid.metal 1.4%, solvat 1.0%, motion 1.0%] – *Physical properties of liquids, with emphasis on correlation functions, relaxation properties, theoretical studies, and [molecular] dynamics.*
- (32) [state 5.2%, model 4.4%, polariz 4.0%, band 2.9%, dynam 2.7%, pair 2.5%, electron 2.4%, sigma 1.8%, coupl 0.9%, hubbard 0.9%] – *[Quantum] state properties, emphasizing model-based predictions, electronic polarizabilities, energy bands, and [quantum] dynamic behavior.*
- (32) [energi 14.8%, electron 3.9%, bind.energi 3.5%, band 3.1%, atom 2.5%, bind 2.1%, cluster 1.8%, correl.energi 1.3%, theori 1.2%, approxim 1.2%] – *Electron energy, with emphasis on binding energy, band structure, and atomic charge.*

- (50) [energi 39.2%, ground.state 1.1%, degeneraci 1.0%, ground 0.9%, quantum 0.8%, mechan 0.7%, polaron 0.7%, state 0.7%, energi.transfer 0.7%, interact 0.7%] – *Quantum energy, with emphasis on ground-state structures, degeneracy, and transfer mechanisms.*
- (33) [state 19.0%, ion 4.5%, reson 3.3%, electron 2.6%, orbit 2.3%, energi 2.2%, ioniz 2.1%, ground 1.7%, excit 1.6%, ground.state 1.3%] – *State properties, particularly ionic, electronic, and resonance states, with emphasis on molecular orbitals, ionization energies, and ground/excited state behavior.*
- (23) [calcul 7.8%, collis 6.9%, collis.strength 6.2%, electron 3.5%, strength 2.7%, transit 2.5%, rule 2.3%, state 1.8%, configur 1.6%, configur.interact 1.4%] – *Theoretical calculations, particularly involving electron collisions/collision strength, with emphasis on transition energies, use of sum rules, and state properties.*
- (17) [dipol 11.0%, atom 6.4%, caviti 3.8%, interact 2.5%, dipol.dipol.interact 2.4%, moment 2.3%, mndo 2.3%, dipol.interact 2.2%, dipol.moment 1.9%, dipol.dipol 1.9%] – *Dipoles in atomic systems, particularly in controlled cavities, with emphasis on dipole-dipole interaction, dipole moments, and the MNDO method (in calculating electrical polarizability).*
- (19) [laser 31.2%, pump 11.1%, puls 4.2%, signal 2.2%, reson 1.3%, intens 1.3%, optic 1.2%, dye.laser 1.1%, equat 1.0%, drawdown 0.9%] – *Lasers, particularly pumped lasers and laser pulses, with emphasis on resulting signals, resonance spectra, beam intensity, and optical pulse properties.*
- (27) [star 15.8%, emiss 14.9%, line 2.0%, band 1.8%, system 1.4%, spectrum 1.1%, binari 1.1%, period 1.1%, bi3 1.1%, outburst 1.1%] – *Stars, emphasizing emission lines/bands, binary systems (and associated periods), and excitation spectra.*
- (22) [galaxi 18.4%, radio 13.0%, cluster 6.1%, ngc 3.7%, shell 2.6%, emiss 2.0%, quasar 1.1%, remnant 1.0%, vela 1.0%, mag 0.9%] – *Studies of galaxies, particularly radio galaxies from the New General Catalog (NGC), with emphasis on galactic clusters, shell structures, emission lines, and quasars.*
- (21) [rai 14.2%, kev 13.3%, hard 6.0%, detector 5.8%, hard.rai 3.4%, sourc 2.4%, energi 2.0%, rai.sourc 1.7%, photon 1.6%, background 1.0%] –*X-rays, particularly hard X-rays (15-120 keV range), with emphasis on sources and detectors, photon energies, and background characteristics.*

- (25) [cosmic 9.4%, solar 6.5%, cosmic.rai 6.2%, energi 5.7%, flare 5.1%, high.energi 4.1%, muon 3.7%, rai 2.9%, shower 2.7%, solar.flare 1.9%] – *Cosmic rays, solar flares, and other high-energy cosmic phenomena.*
- (19) [fission 15.6%, gamma 5.6%, alpha 4.6%, kev 2.9%, mev 2.7%, gamma.rai 2.0%, state 1.6%, rai 1.5%, measur 1.4%, peak 1.4%] – *Nuclear fission, with emphasis on gamma-ray spectroscopy (in keV-MeV energy range), alpha particles, and nuclear states.*
- (17) [multipl 8.4%, collis 6.0%, hadron 5.3%, fragment 3.4%, emuls 3.0%, free.path 2.1%, mean.free 2.1%, mean.free.path 2.1%, projectil 1.9%, gev 1.4%] – *Multiplicity in nuclear collisions, with emphasis on hadron emission, target fragmentation, and nuclear emulsion.*
- (36) [quark 40.5%, decai 3.2%, meson 3.2%, gluon 3.1%, mass 2.7%, model 2.4%, baryon 1.8%, charm 1.8%, hadron 1.2%, nucleon 1.2%] – *Quarks, particularly quark activity in decaying neutrons, with emphasis on interactions involving mesons, gluons, and baryons, as well as mass models.*
- (24) [neutrino 17.1%, higg 10.5%, decai 4.3%, mass 3.5%, boson 2.4%, lepton 2.2%, model 2.1%, flavor 2.0%, higg.boson 1.8%, gev 1.4%] – *Neutrinos (subatomic particles from the lepton family) and the Higgs boson, with emphasis on decay, mass predictions, and modeling.*
- (16) [rotat 9.9%, static 3.1%, dust 2.8%, star 2.8%, white.dwarf 2.7%, electromagnet 2.6%, model 2.6%, univers 2.3%, dwarf 2.3%, charg.dust 2.2%] – *Rotation in cosmological systems, with emphasis on static sources/fields, charged [cosmic] dust, stars (e.g. white dwarves), and electromagnetic models.*
- (13) [bianchi 11.0%, bianchi.type 10.0%, cosmolog 7.5%, model 5.7%, cosmolog.model 3.0%, lyra 3.0%, bianchi.type.iii 2.4%, univers 2.3%, lyra.geometri 2.1%, type.iii 2.1%] – *Bianchi cosmological models of various types, particularly in the framework of Lyra geometry.*
- (51) [model 53.3%, experiment 0.9%, paramet 0.8%, model.model 0.8%, model.paramet 0.7%, system 0.5%, data 0.4%, simul 0.4%, experiment.data 0.4%, even 0.3%, phase 0.3%] – *Use of scientific and mathematical models in experimentation, with emphasis on model parameters, system behavior, and data acquisition.*
- (20) [model 6.6%, cover 3.5%, reson.frequenc 3.5%, patch 3.1%, eros 2.9%, theoret 2.3%, materi 1.7%, wolff.model 1.5%, experiment 1.5%, wolff 1.3%] – *Theoretical models, particularly the Wolff model, with*

*emphasis on covered/uncovered patch antennae, resonance frequencies, and erosion.*

- (14) [capacit 2.5%, order.elast 2.5%, order.elast.constant 2.5%, heavili.dope 2.3%, elast.constant 2.3%, potenti 1.9%, surfac.photovoltag 1.8%, heavili 1.7%, photovoltag 1.6%, gap.narrow 1.6%] – *Electrical properties, particularly capacitance, but also emphasizing n-order elastic constants, heavily doped materials, and electric potential.*

2.1.2. Materials Engineering

**2.1.2.1. Physical Inorganic Chemistry/Materials Science**

- (21) [copolym 23.9%, methacryl 5.6%, reactiv.ratio 4.7%, copolymer 3.8%, mma 2.8%, reactiv 2.7%, tudo 1.7%, kelen 1.7%, kelen.tudo 1.7%, nmr 1.6%] – *Copolymers, particularly methacrylates (e.g. methyl methacrylate, MMA), with emphasis on reactivity ratios, the Kelen-Tudos method, and nuclear magnetic resonance (NMR) spectroscopy.*
- (14) [graft 46.3%, microspher 4.5%, graft.yield 3.3%, methacryl 2.0%, jute.fiber 1.4%, copolymer 1.2%, graft.copolym 1.1%, graft.copolymer 1.1%, monom 1.1%, radiopaqu 1.0%] – *Grafting, particularly grafting of microspheres and graft copolymerization, with emphasis on graft yield and [graft] copolymerization of methacrylate onto jute fiber.*
- (30) [blend 36.2%, epdm 5.8%, styren 2.3%, poli 2.3%, melt 2.1%, polym 1.9%, properti 1.0%, shear.rate 0.9%, pbr 0.9%, temperatur 0.9%] – *Properties of blend compositions, particularly ethylene propylene diene terpolymer (EPDM) and styrene blends, with emphasis on polymers, melt rheology, and shear rates.*
- (24) [rubber 25.0%, blend 16.1%, vulcaniz 6.7%, enr 2.5%, vulcan 1.7%, filler 1.4%, neopren 1.3%, miscibl 1.2%, natur.rubber 1.1%, fill 0.9] – *Rubber and rubber blends, with emphasis on vulcanization, epoxidized natural rubber (ENR), and filler structure.*
- (20) [fiber 13.2%, resin 6.2%, mechan.properti 2.9%, properti 2.3%, fabric 2.3%, finish 2.1%, strength 2.0%, diisocyan 1.7%, mechan 1.7%, earthen 1.6%] – *Fibers and resins, with emphasis on mechanical properties, uses in fabrics (finishing), and strength improvement.*
- (24) [composit 15.6%, fibr 7.6%, strength 6.5%, tensil 4.5%, reinforc 2.9%, sic 2.8%, wear 1.9%, tensil.strength 1.8%, glass 1.3%, properti 1.2%] – *Fibers and composites, with emphasis on tensile strength, wear and reinforcement, and incorporation of silicon carbide (SiC).*

- (15) [coat 33.8%, graphit 2.5%, flyash 1.6%, composit 1.3%, microstructur 1.3%, black 1.1%, wear 1.1%, polyurethan 1.1%, deposit 1.0%, optic 0.9%] – *Coatings, particularly onto graphite and composites (e.g. nickel-flyash), with emphasis on microstructure, black [selective] coatings, and wear.*
- (24) [corros 12.8%, wear 9.6%, aluminium 3.2%, alloi 3.1%, grind 2.2%, ball 1.9%, microstructur 1.8%, microscopi 1.7%, steel 1.5%, electron.microscopi 1.3%] – *Corrosion and wear [under grinding abrasian] in metals, particularly aluminumm and its alloys, with emphasis on grinding balls and microstructural properties.*
- (24) [crack 41.3%, crack.growth 4.4%, fractur 3.6%, stress 3.2%, tough 3.1%, crack.tip 2.1%, tip 2.0%, fractur.tough 1.4%, size 1.2%, plastic 1.0%] – *Cracks and crack growth behavior, with emphasis on fracture toughness, stress effects, and crack tip properties.*
- (19) [stress 9.4%, weld 9.1%, strain 8.7%, fatigu 5.1%, strain.rate 3.6%, fatigu.life 3.1%, joint 1.8%, curv 1.7%, life 1.7%, superplast 1.5%] – *Stress and strain in physical systems, particularly those with welded joints/components, emphasizing fatigue life, strain rate, and diagnostic curves.*
- (15) [precipit 7.4%, scc 5.8%, weld 2.8%, boundari 2.6%, grain 2.5%, chromium 2.0%, discontinu.precipit 1.9%, anneal 1.8%, gamma 1.8%, irradi 1.6%] – *Precipitates and precipitation, with secondary focus on stress corrosion cracking (SCC), emphasizing [weld] metals and their grain boundaries as well as chromium content.*
- (27) [strength 6.2%, sinter 6.0%, steel 5.6%, properti 4.1%, ductil 3.9%, microstructur 2.6%, anneal 2.1%, hard 1.7%, alloi 1.7%, mechan.properti 1.7%] – *Mechanical properties of steel and its alloys, particularly strength, sintering properties, ductility, and microstructure.*
- (27) [degre 18.2%, temperatur 11.5%, temperatur.rang 2.2%, rang 1.7%, strain.rate 1.6%, degre.degre 1.2%, strain 1.2%, food 1.0%, absorb 1.0%, brass 1.0%] – *Temperature-dependent systems/processes, with emphasis on strain-rate sensitivity (in metals), food preservation, and selective absorbers.*
- (21) [quartz 4.0%, degre 3.7%, garnet 3.7%, temperatur 2.8%, spinel 2.4%, sic 2.3%, orthopyroxen 1.9%, char 1.7%, asphalten 1.7%, coal 1.5%] – *Properties of minerals, particularly quartz, garnet, and spinel, as well as silicon carbide (SiC), with emphasis on temperature effects.*
- (20) [rock 8.0%, gneiss 6.2%, granit 5.7%, zone 4.8%, charnockit 3.0%, fluid 2.7%, granulit 2.5%, metamorph

2.2%, amphibolit 2.1%, shear 1.5%] – *[Mainly igneous/metamorphic] rocks, such as gneiss, granite, granulite and charnockite rocks, with emphasis on the zones where they are found and on their fluid phases.*

- (29) [oxid 42.8%, oxygen 1.3%, temperatur 1.3%, surfac 1.2%, electrod 1.2%, tio2 1.1%, plasma 1.0%, zirconia 0.8%, precipit 0.8%, neptunium 0.7%] – *Oxides and oxidation, with emphasis on temperature, surface properties, and electrode behavior.*
- (27) [spinel 5.3%, dta 4.6%, rai 4.1%, ferrit 2.7%, phase 2.6%, fe2o3 2.3%, caso4 2.3%, xrd 1.9%, degre 1.7%, diffract 1.6%] – *Properties of spinels and ferrites, with emphasis on differential thermal analysis (DTA), X-ray analysis, and phase transitions.*
- (22) [diffract 8.3%, zro2 4.7%, crystallin 3.9%, rai.diffract 3.0%, rai 2.4%, eutect 1.4%, electron.diffract 1.3%, chemisorpt 1.3%, monoclin 1.1%, v2o5 1.0%] – *Electron- and X-ray diffraction, particularly in zirconia ($ZrO_2$), as well as other crystalline and eutectic materials.*
- (27) [phase 22.6%, diagram 4.4%, transit 4.3%, phase.transit 2.8%, smectic 2.1%, phase.diagram 1.4%, nemat 1.3%, slag 1.2%, crystal 1.0%, sampl 0.9%] – *Phase transitions and associated phase diagrams, with emphasis on smectic/nematic phases.*
- (35) [phase 34.8%, alloi 2.6%, anneal 2.3%, icosahedr 1.6%, sampl 1.1%, cubic 1.1%, disord 1.0%, temperatur 1.0%, icosahedr.phase 0.9%, diffract 0.9%] – *Phase properties of alloys, particularly in relation to annealing, with emphasis on icosahedral/cubic phases, [structural] disordering, and temperature effects.*
- (31) [sampl 6.8%, phase 5.9%, singl.phase 5.1%, superconduct 5.0%, composit 3.8%, resist 3.5%, sinter 3.1%, 2223 2.8%, nomin.composit 2.3%, singl 1.9%] – *Sample treatment/analysis in phase studies, with emphasis on single-phase materials, superconducting phases, material composition, and resistivity behavior.*
- (30) [superconduct 36.6%, thermopow 4.3%, transit 1.9%, cuprat 1.6%, superconduct.transit 1.6%, temperatur 1.6%, compound 1.5%, superconductor 1.3%, structur 1.1%, phase 1.1%] – *Superconductors and superconductivity, with emphasis on thermopower measurements, superconducting transitions (and associated transition temperatures), and superconducting cuprates.*
- (31) [oxygen 12.6%, yba2cu3o7 9.6%, superconduct 6.5%, delta 3.6%, compound 2.2%, yba2cu3o7.delta 1.9%, site 1.4%] – *Oxygen, particularly its behavior in the*

*superconducting compound $YBa_2Cu_3O_7$-delta, as well as in other related compounds.*

- (23) [transit 7.7%, raman 7.5%, gpa 6.4%, phase.transit 5.3%, phase 3.6%, mode 3.1%, spectra 2.9%, phonon 2.4%, crystal 1.8%, vibrat 1.8%] – *Phase transitions, particularly as studied through Raman spectroscopy, and with emphasis on pressure variation (in GPa range), phonon modes, and vibrational behavior.*
- (19) [vibrat 6.8%, photon 6.6%, mode 5.8%, frequenc 4.7%, two.photon 3.6%, raman 3.5%, spectra 2.1%, laser 1.7%, potenti.energi.distribut 1.7%, potenti.energi 1.7%] – *Vibration, particularly vibrational modes, frequencies, and spectra, with emphasis on one- and two- photon spectroscopy, Raman spectra, and potential energy distribution.*
- (23) [phonon 24.4%, anharmon 7.8%, phonon.dispers 4.7%, forc 3.7%, forc.constant 3.1%, impur 2.3%, dispers 2.1%, constant 1.3%, neutron 0.9%, model 0.9%] – *Phonons and phonon dispersion, particularly in anharmonic crystals, with emphasis on force constants, impurities, and neutron scattering.*
- (31) [neutron 22.1%, spectromet 6.2%, mev 3.7%, neutron.scatter 3.6%, scatter 3.2%, coher 1.0%, photon 1.0%, resolut 0.9%, squeez 0.8%, torsion 0.8%] – *Neutrons and neutron scattering (esp. coherent scattering), particularly through the use of photon spectrometry, with emphasis on scattering experiments in MeV energy-transfer range.*
- (31) [diod 9.1%, frequenc 7.1%, nois 3.4%, point.contact 3.4%, current 3.0%, microstrip 2.0%, puls 1.7%, point 1.6%, contact 1.4%, low 1.3%] – *Diodes, with emphasis on frequency coverage/response, noise generation, point contact studies, and current characteristics.*
- (30) [voltag 8.3%, current 3.5%, silicon 3.3%, electrod 2.8%, silicid 1.6%, devic 1.5%, electrolyt 1.5%, breakdown 1.4%, cadmium 1.4%, breakdown.voltag 1.3%] – *Voltage and current characteristics in electrical systems/devices, emphasizing silicon properties (esp. silicide-silcon interface), electrode characteristics, and electrolyte concentration (and associated effects on breakdown).*
- (20) [grain 5.8%, diffus 5.5%, voltag 4.8%, grain.boundari 4.7%, layer 2.6%, boundari 2.4%, dope 1.8%, thyristor 1.8%, resist 1.3%, trap 1.3%] – *Grain structure in materials, particularly grain boundary effects*

*on diffusion and voltage properties, with emphasis on doped layers.*

- (16) [diffus 20.9%, diffus.coeffici 3.8%, coeffici 2.5%, fuel 2.1%, thermal.conduct 2.0%, pellet 1.8%, thermal 1.7%, sorption 1.6%, temperatur 1.4%, gel 1.0%] – *Diffusion and determination of diffusion coefficients, with secondary emphasis on fuel/fuel pellets and associated thermal conductivity properties.*
- (17) [track 8.9%, defect 6.7%, ion 4.9%, energi 3.9%, supercoil 3.6%, dna 3.0%, channel 1.9%, hole 1.6%, loss.rate 1.3%, energi.loss 1.2%] – *Nuclear track research involving energy loss/defects in ions and ionic crystals, as well as on supercoiling properties of DNA.*
- (15) [gold 27.4%, etch 20.7%, diamond 3.4%, etch.rate 2.0%, sensit 1.7%, genesi 1.4%, detector 0.9%, surfac 0.9%, pore 0.8%, laser 0.8%] – *Properties of gold and diamond, with emphasis on etch rate [of diamond], detector sensitivity, [gold] genesis, and surface characteristics.*
- (35) [crystal 32.1%, singl.crystal 4.4%, singl 2.0%, temperatur 1.8%, grown 1.5%, irradi 1.5%, rai 1.3%, glow.peak 1.2%, glow 1.2%, optic 1.0%] – *Crystal structures, particularly single-crystal structures, with emphasis on temperature effects, crystal growth, and irradiation including X-ray diffraction techniques.*
- (27) [crystal 10.3%, transit 4.0%, glass 3.6%, glass.transit 3.0%, glassi 2.2%, isotherm 2.0%, temperatur 1.9%, mossbauer 1.6%, transit.temperatur 1.6%, gel 1.3%] – *Transitions between crystal- and glass- phases of materials, with emphasis on isothermal transitions, glass transition temperature, and Mossbauer spectroscopy.*
- (27) [spectra 21.8%, band 5.8%, absorpt 3.3%, mossbauer.spectra 2.4%, transit 2.4%, mossbauer 1.8%, jute.stick 1.4%, ion 1.3%, stick 1.1%, glass 1.0%] – *Spectra and spectral analysis, emphasizing absorption bands and gaps, Mossbauer spectra, and transition properties.*
- (34) [glass 9.1%, temperatur 4.8%, resist 4.3%, electr 2.6%, magnet 2.3%, ion 1.9%, lattic 1.8%, sio2 1.6%, fe3 1.5%, 300 1.2%] – *Electrical, magnetic, and thermal properties of glasses, including resistivity, temperature dependencies, and ion activity.*
- (27 ) [dielectr 27.8%, dielectr.constant 10.9%, constant 3.8%, temperatur 3.2%, dielectr.loss 2.8%, frequenc 2.4%, loss 2.2%, khz 1.7%, conduct 1.1%, temperatur.rang 0.8%] – *Properties of dielectric materials – dielectric*

*constant, electrical conductivity, dielectric loss – over various temperature and frequency ranges.*

- (38) [conduct 14.3%, temperatur 7.6%, electr 3.7%, electr.conduct 2.3%, hop 1.6%, carrier 1.3%, region 1.3%, sampl 1.2%, dope 1.2%, measur 1.2%] – *Electrical conductivity of materials at various temperatures, with emphasis on hopping mechanisms, [charge] carrier concentration, and doped samples.*

**2.1.2.2. Thin Films**

- (19) [film 15.3%, conduct 8.7%, temperatur 6.1%, temperatur.rang 3.8%, dope 3.3%, electr 3.1%, electr.conduct 2.5%, rang 1.9%, thermoelectr.power 1.2%, thermoelectr 1.1%] – *Film properties – electrical conductivity, doping level, thermoelectric power – over various temperature ranges.*
- (32) [film 20.3%, optic 7.2%, gap 4.5%, band.gap 3.2%, band 2.8%, deposit 2.0%, thin.film 1.6%, absorpt 1.6%, substrat 1.5%, hydrogen 1.4%] – *Thin films in optical applications, emphasizing band gap properties, deposition techniques, and optical absorption studies.*
- (101) [film 58.0%, deposit 5.0%, substrat 3.3%, anneal 1.5%, thin.film 1.3%, thin 1.2%, film.deposit 0.9%, sputter 0.7%, superconduct 0.6%, oxygen 0.5%] – *Thin films and deposition techniques (esp. sputter deposition), with emphasis on substrate properties, effects of annealing, and superconductivity.*

2.2. Applied/Analytical Chemistry, Biochemistry, Kinetics

2.2.1. Analytical Chemistry, Kinetics

**2.2.1.1. Analytical Chemistry**

- (23) [bond 36.7%, crystal 2.4%, bond.length 1.9%, bond.order 1.6%, ring 1.4%, hydrogen 1.3%, structur 1.2%, group 1.1%, hydrogen.bond 1.1%, dimer 0.8%] – *Bonding properties in crystals, particularly bond length and bond order, with emphasis on ring structures, hydrogen bonds, and dimers.*
- (22) [conform 20.8%, ring 5.0%, chemic.shift 3.2%, shift 3.1%, chemic 1.7%, alkyl 1.0%, trna 1.0%, group 0.9%, adduct 0.9%, delta 0.8%] – *Conformational analysis of chemical compounds (esp. alkyl compounds), with emphasis on ring structures, chemical shifts, and transfer RNA (tRNA).*
- (38) [solvent 35.8%, triplet 5.9%, solvat 1.5%, polar 1.5%, fluoresc 1.5%, mixtur 1.0%, state 0.8%, polar.solvent 0.8%, quench 0.8%, acetonitril 0.8%] – *Solvents, with emphasis on triplet properties [in various*

*solvents], solvation, solvent polarity, and fluorescence spectral studies.*

- (35) [excess 11.0%, mixtur 8.9%, viscos 6.6%, molar 2.9%, volum 2.2%, excess.molar 2.1%, binari 2.1%, excess.volum 2.0%, gibb 1.6%, binari.mixtur 0.8%] – *Excess properties – molar viscosity, volume, Gibbs free energy – in various mixtures, particularly binary mixtures.*
- (27) [poli 7.5%, micel 4.4%, paa 2.2%, solut 1.9%, acetonitril 1.7%, aqueou 1.6%, water 1.5%, amin 1.4%, poli.ethylen 1.3%, fluoresc 1.2%] – *Polymers and micelles, with emphasis on polyacrylic acid (PAA), acetonitrile, polyethylene, and various aqueous solutions.*
- (30) [delta 10.7%, thermodynam 3.8%, mol 3.4%, enthalpi 3.3%, delta.degre 3.1%, degre 3.0%, liquid 2.2%, temperatur 2.0%, micel 1.3%, cdte 1.2%] – *Thermodynamic parameters in various systems (esp. liquids), with emphasis on molar quantities and enthalpy and temperature measurements.*
- (25) [solut 8.2%, solid.solut 5.7%, electrod 4.3%, membran 4.2%, solid 4.1%, coeffici 2.6%, kcl 2.4%, composit 1.8%, activ.coeffici 1.4%, mixtur 1.4%] – *Solid solutions, as well as properties of electrodes and membranes, with emphasis on activity coefficients, composition, and potassium chloride (KCl) solutions.*
- (25) [absorpt 7.5%, spectrophotometr 6.2%, molar.absorpt 5.0%, beer 3.6%, beer.law 3.2%, molar 3.0%, sensit 2.3%, complex 2.1%, absorpt.maximum 2.0%, extract 2.0%] – *Molar absorption and spectrophotometric methods of determining material properties, with emphasis on Beer's Law, compound/complex sensitivity, and maximum absorption.*
- (24) [extract 6.9%, thallium 3.6%, zinc 3.2%, bismuth 2.9%, separ 2.6%, indium 2.0%, copper 1.9%, atom.absorpt 1.9%, sampl 1.7%, radiochem 1.6%] – *Extraction/separation methods involving various elements – thallium, zinc, bismuth, indium, copper – with emphasis on atomic absorption and radiochemical methods.*
- (25) [extract 20.2%, uranium 7.2%, acid 4.2%, plutonium 3.5%, iii 2.8%, cmp 1.8%, solut 1.5%, quantit.extract 1.4%, separ 1.2%, nitric.acid 1.1%] – *Extraction/separation methods involving uranium, plutonium, CMP, and various acids, with emphasis on quantitative extraction.*
- (36) [acid 16.9%, resin 7.3%, preconcentr 2.1%, ion 1.8%, exchang 1.3%, metal 1.3%, anhydrid 1.2%, separ 1.2%, corros 1.0%, quantit 1.0%] – *Acids and resins, with*

*emphasis on preconcentration, ion exchange (esp. in metals), anhydrides, and separation properties.*

- (29) [acid 28.3%, fatti 7.5%, fatti.acid 4.7%, glycolipid 3.8%, lipid 3.0%, kokum 0.7%, neutral.lipid 0.7%, phospholipid 0.7%, total 0.6%, amino 0.6%] – *Acids, particularly fatty acids, with emphasis on lipids (glycolipids, neutral lipids, phospholipids), kokum (fat of tree origin), as well as amino acids.*
- (24) [extract 5.4%, galactos 4.0%, lignan 3.4%, total.synthesi 2.8%, acid 2.8%, dye 2.1%, first.total.synthesi 2.1%, first.total 2.1%, mole 1.9%, arabinos 1.7%] – *Extraction and synthesis methods, particularly those involving galactose, lignans, various acids, and dyes, with emphasis on first total syntheses.*
- (24) [dye 22.0%, gce 2.7%, electrod 2.2%, anion 1.8%, transport 1.3%, ion 1.3%, silica 1.3%, silica.gel 1.1%, oligom 1.1%, metal 0.9%] – *Properties of dyes, particularly in silica gel mixtures, with secondary emphasis on glassy carbon electrodes (GCEs), particularly anion and ion transport behavior.*
- (29) [adsorpt 39.3%, adsorb 2.4%, surfac 2.0%, leach 1.6%, desorpt 1.5%, metal 1.2%, concentr 1.0%, ion 0.9%, surfac.area 0.8%, adsorpt.desorpt 0.7%] – *Adsorption/desorption properties in various materials/systems, with emphasis on surface area, leaching techniques, and concentration of [metal] ions.*

**2.2.1.2. Chemical Kinetics**

- (10) [opr 49.6%, obu 13.1%, zr2 3.8%, zr2.opr 3.8%, alkoxid 3.0%, opr.opr 2.8%, obu.obu 1.6%, bimetal 1.0%, element.spectroscop 0.6%, reaction 0.6%] – *Focuses on synthesis of various bimetallic poly alkoxide substituted materials, with systems varying according to metals and alkoxide used (methyl, propyl, butyl, etc.) and generally synthesized via a metathetical type reaction between the metal halide and the appropriate alkali metal alkoxide in the required stoichiometry.*
- (17) [oar 17.5%, nmr 3.0%, molar.ratio 2.2%, ch2 2.1%, molecular.weight 1.9%, element 1.8%, molar 1.7%, spectral 1.7%, c6h5 1.5%, cyclo 1.5%] – *Focuses on synthesis of various mono- and bimetallic aryloxide materials, with systems varying according to metals and aryloxide used (aryl/alkylphenols, arylazophenols, naphthols) and generally synthesized by a metathetical type reaction between metal halide or metal carbonyl and the appropriate alkali metal aryloxide in the required stoichiometry.*

- (15) [metal 6.1%, chelat 3.5%, c2o4 3.0%, fe2ru 2.9%, polychel 2.8%, pph3 2.4%, compound 1.3%, fe2 1.3%, spectral 1.3%, chemic.spectral 1.3%] – *Properties of metals and [poly]chelates, particularly compounds/complexes containing $C_2O_4$, $Fe_2Ru$, or $PPh_3$, with emphasis on chemical analysis and IR spectral studies.*
- (26) [decomposit 27.5%, kinet.paramet 4.8%, kinet 4.1%, thermal.decomposit 2.9%, thermal 1.8%, oxal 1.6%, reaction 1.2%, horowitz.metzger 1.0%, metzger 1.0%, horowitz 1.0%] – *Decomposition reactions, particularly thermal decomposition, with emphasis on kinetic parameters, oxalates, and [application of ] Horowitz-Metzger equations.*
- (29) [polym 6.3%, resin 4.3%, viscos 2.5%, molecular.weight 2.5%, diamin 2.0%, monom 1.9%, averag.molecular 1.9%, averag.molecular.weight 1.9%, cure 1.8%, thermal 1.7%] – *Properties of polymers and constituent monomers, particularly resins and diamines, emphasizing viscosity, average molecular weight, and thermal properties.*
- (34) [catalyst 39.8%, oxid 3.4%, hydrogen 2.9%, select 2.2%, support 1.5%, al2o3 1.4%, reaction 1.3%, deactiv 1.1%, mgo 1.0%, catalyt 1.0%] – *Catalysts in chemical reactions, with emphasis on oxidation and hydrogenation reactions, selectivity, and catalyst supports.*
- (21) [zeolit 9.2%, zsm 8.1%, catalyt 8.1%, catalyt.activ 4.2%, tio2 3.3%, oxid 2.6%, select 2.2%, sio2.al2o3 2.0%, sio2 1.6%, acid 1.4%] – *Zeolites, with emphasis on catalytic activities in single oxides - $TiO_2$, $SiO_2$, $Al_2O_3$ – as well as selectivity properties.*
- (19) [alkyl 8.7%, alder 6.0%, diel.alder 6.0%, diel 5.8%, reaction 4.9%, heterocycl 2.8%, synthesi 1.6%, format.fuse 1.5%, lead.format.fuse 1.5%, cyclohexadien 1.5%] – *Properties of alkyl groups, emphasizing formation of fused heterocycles, as well as on Diels-Alder reactions, emphasizing compound synthesis.*
- (45) [reaction 33.5%, product 4.5%, chlorid 1.5%, oxid 1.2%, yield 1.1%, correspond 0.9%, aldehyd 0.8%, step 0.8%, lead 0.8%, na2so4 0.7%] – *Chemical reactions and corresponding products, with emphasis on chlorides, oxides, and aldehydes, as well as yield.*
- (27) [oxid 9.1%, reduct 4.0%, keton 3.4%, acid 2.9%, olefin 2.1%, reaction 1.8%, baker 1.6%, baker.yeast 1.6%, singl.pot 1.4%, afford 1.2%] – *Oxidation and reduction reactions, particularly those involving ketones, acids, and olefins, as well studies on baker's yeast.*

- (28) [alcohol 17.0%, acet 12.5%, acid 3.6%, ester 2.8%, carboxyl 1.6%, acet.acid 1.5%, tertiari 1.5%, hydrobor 1.3%, ethyl 1.3%, oxid 1.3%] – *Series of organic compounds, with emphasis on alcohols, acetic acid, esters, carboxyl groups, hydrocarbons, and ethyl groups.*
- (43) [oxid 13.0%, rate 6.6%, reaction 4.6%, order 3.7%, first.order 3.0%, kinet 2.5%, acid 2.3%, iii 2.0%, first 1.5%, kinet.oxid 1.4%] – *Oxidation reactions, with emphasis on reaction rate, order (esp. first), and oxidation kinetics.*
- (27) [rate 7.8%, reaction 5.3%, rate.law 3.7%, kinet 3.6%, first.order 3.1%, order 3.0%, law 2.0%, oxid 1.9%, nba 1.8%, acid 1.8%] – *Reaction rates, as given by corresponding rate laws, with emphasis on kinetics, reaction order (esp. first), and oxidation reactions.*
- (27) [kinet 11.7%, reaction 7.8%, polymer 2.5%, oxyhaemoglobin 2.3%, mol 1.4%, cure 1.2%, polarographi 1.2%, rate 1.2%, bsa 0.9%, activ.energi 0.9%] – *Kinetic parameters in chemical reactions, with emphasis on polymerization, oxyhemoglobins, curing processes, and polarography.*
- (28) [radic 9.3%, rate.constant 4.0%, reaction 3.9%, electron 3.7%, electron.transfer 3.3%, rate 2.6%, transfer 2.0%, constant 1.9%, transient 1.7%, amin 1.6%] – *Reactions involving free radicals, with emphasis on rate constants, electron transfer, and transient species.*
- (35) [rate 7.9%, reaction 5.5%, rate.constant 4.9%, constant 4.0%, mol 3.1%, delta 2.9%, dissoci 1.8%, delta.equal 1.6%, kinet 1.6%, degre 1.5%] – *Reaction rates and corresponding rate constants, with emphasis on dissociation processes and reaction kinetics.*

2.2.2. Biochemistry

### 2.2.2.1. Properties of Biomolecular Complexes

- (31) [complex 13.7%, delta 4.1%, ligand 3.0%, crown 2.5%, stabil 2.3%, constant 1.9%, format.constant 1.8%, base 1.6%, stabil.constant 1.6%, metal 1.5%] – *Properties of complexes, with emphasis on constituent ligands, stability, and formation constants.*
- (10) [iii.iii 33.4%, iii 23.4%, iii.iii.iii 20.5%, ligand 1.5%, complex 1.4%, trifluoroacetyl 0.6%, benzoyl 0.6%, invers 0.5%, monochloroacetyl 0.5%, picrat 0.5%] – *Complexes and constituent ligands, including trifluoroacetyl-, monochloroacetyl-, and benzoyl- groups.*
- (59) [complex 45.9%, pph3 2.3%, metal 2.3%, ligand 1.4%, nmr 0.9%, reaction 0.7%, ion 0.6%, spectra 0.6%, bond 0.5%, synthes 0.5%] – *Properties of complexes,*

*particularly those involving various metals and $PPh_3$ ligands, with emphasis on nuclear magnetic resonance (NMR) spectral studies, reaction properties, and ion behavior.*

- (35) [complex 15.3%, cobalt 8.7%, schiff 6.6%, schiff.base 6.2%, base 3.7%, ligand 2.5%, iii 2.3%, nickel 2.1%, h2o 1.8%, chelat 1.2%] – *Properties of complexes, particularly cobalt and Schiff base complexes, and their constituent ligands.*
- (54) [complex 21.3%, ligand 6.1%, spectral 2.6%, element 1.7%, electron 1.5%, magnet 1.4%, atom 1.4%, conduct 1.0%, characteris 0.8%, complex.characteris 0.8%] – *Properties of complexes and their constituent ligands, with emphasis on spectral studies (esp. electronic), elemental analysis, and magnetic properties.*
- (16) [ethanediamin 7.0%, h2o 4.5%, pyrazolin.on 3.3%, complex 3.2%, pyrazolin 3.1%, benzimidazol 2.9%, phenyl.pyrazolin 1.9%, phenyl.pyrazolin.on 1.9%, methyl 1.7%, cf3so3 1.6%] – *Various molecular complexes, particularly ethanediamine-, pyrazoline- and phenyl-pyrazoline-, benzimidazole, and methyl- groups.*

**2.2.2.2. Biomolecular Synthesis**

- (52) [angstrom 39.2%, degre 2.5%, alpha 2.1%, crystal 1.8%, reflect 1.8%, beta 1.6%, structur 1.6%, ring 1.5%, space.group 1.4%, angstrom.beta 1.3%] – *Atomic-scale measurements (i.e. angstroms/angular degrees) in systems, emphasizing crystal physical properties, observed reflections, and ring structures.*
- (42) [beta 43.6%, alpha 6.7%, alpha.beta 3.1%, beta.hydroxi 1.5%, hydroxi 1.0%, beta.beta 0.9%, orchid 0.9%, new 0.9%, glucopyranosyl 0.8%, beta.glucopyranosyl 0.8%] – *Organic complexes, particularly those in hydroxy- and beta-hydroxy- as well as glucopyranosyl- and beta-glucopyranosyl- groups, with emphasis on new complexes.*
- (32) [synthesi 15.9%, alpha 14.1%, stereoselect 4.9%, prisman 2.2%, synthesi.ci 1.7%, keton 1.7%, stereoselect.synthesi 1.6%, lacton 1.2%, bf3 1.2%, methyl 1.1%] – *Organic synthesis, particularly stereoselective synthesis, with emphasis on prismanic frameworks, ketones, and lactones.*
- (27) [methyl 20.8%, benzopyran 5.0%, benzopyran.on 4.1%, dihydro 3.7%, rearrang 2.8%, dimethyl 2.5%, methyl.methyl 1.9%, tetrahydro 1.9%, pyran 1.8%, quinolin 1.7%] – *Organic complexes, particularly those containing methyl- and dimethyl- groups, as well as those*

*containing benzopyran-, dihydro-, tetrahydro-, and pyran groups.*

- (25) [aryl 29.3%, synthesi 3.2%, phenyl 2.6%, condens 2.0%, afford 1.9%, on 1.6%, bicyclo 1.5%, oxazolin.on 1.4%, oxazolin 1.4%, synthesi.aryl 1.3%] – *Synthesis of organic complexes containing aryl- or phenyl- radicals, with emphasis on condensation, bicyclo- structures, and oxazolin- groups.*
- (34) [substitut 13.5%, compound 11.8%, synthesis 2.7%, aromat 2.4%, deriv 2.2%, phenyl 2.0%, amin 1.5%, amino 1.2%, acridin 1.1%, alkyl 1.0%] – *Substitution reactions, particularly in the synthesis of various compounds, with emphasis on aromatic structures, and complex derivatives stemming from amine-, acridine-, and alkyl- groups.*
- (29) [nmr 11.8%, compound 9.9%, bi 5.6%, substitu 2.0%, spectra 1.3%, phase.transfer 1.3%, structur 1.3%, allyl 1.1%, solid.state 0.9%, tetraquinan 0.8%] – *Nuclear magnetic resonance (NMR) spectroscopy in studying structural and spectral properties of compounds (particularly allyl- groups), with emphasis on substituents, phase transfer, and solid state properties.*

## A3-2. 2002 DATABASE

The following flat taxonomy can be generated from the Level 4 categories of Figure A3-2. The bullets under each category represent the 256 elemental cluster themes:

3. Physical and information sciences
   3.1. Physical/digital systems and modeling
      3.1.1. Computer science

**3.1.1.1. Artificial intelligence**

- (46) [network 20.4%, neural 16.8%, neural.network 14.9%, train 5.4%, ann 2.0%, model 2.0%, artifici.neural 1.6%, artifici.neural.network 1.6%, artifici 1.2%, input 1.0%] – *Use of artificial neural networks (ANNs) as models for natural, industrial, and computational systems with emphasis on the training potential of these networks.*
- (41) [network 43.1%, traffic 1.9%, multimedia 1.8%, scheme 1.0%, secur 0.9%, optic 0.9%, paper 0.9%, rout 0.8%, resourc 0.8%, qo 0.7%] *Networks, with emphasis on transmission, multimedia traffic optimization, and security.*

**3.1.1.2. Systems optimization**

- (17) [commerc 11.9%, inform 8.8%, internet 6.9%, mobil 4.5%, broadcast 4.1%, secur 2.8%, digit 2.3%, checkpoint 2.1%, emc 1.7%, access 1.7%] –*Commercialization of* *mobile/wireless internet capabilities, with emphasis on information broadcasting systems.*

- (16) [server 13.1%, workflow 9.3%, queue 7.5%, distribut 6.5%, citat 3.1%, mine 2.4%, busi 1.9%, model 1.6%, busi.period 1.3%, paper 1.2%] – *Network data servers with emphasis on modeling and enhancing business and general workflow using queuing and distributed computing principles.*
- (16) [script 8.6%, languag 7.7%, text 6.1%, web 4.5%, file 4.2%, speech 3.9%, recognit 3.3%, word 3.1%, document 2.4%, book 1.7%] – *Automated script and speech recognition/processing (i.e. conversion to text) in various languages for use in web and other computing applications.*
- (28) [system 31.7%, plan 2.0%, comput 1.0%, model 1.0%, featur 1.0%, maintain 0.9%, paper 0.9%, behavior 0.8%, state 0.8%, cost 0.8%] – *Modeling the behavior and features of various types of systems using computational analysis/planning.*
- (22) [satellit 4.9%, paper 3.9%, commun 3.4%, sector 2.4%, resourc 2.2%, microwav 2.2%, remot.sens 1.7%, gain 1.5%, ir 1.5%, remot 1.5%] – *Uses of remote sensing satellites as means of communicating data valuable to (natural) resource management/monitoring.*
- (17) [fuzzi 39.1%, rule 2.9%, fuzzi.set 1.9%, fuzzi.control 1.8%, part 1.6%, manufactur 1.6%, cluster 1.3%, system 1.3%, inspect 1.1%, membership 0.9%] – *"Fuzzy" system methodologies used to determine manufacturing and design guidelines for various procedures.*
- (25) [fault 18.3%, failur 11.9%, reliabl 10.5%, corros 3.0%, system 2.6%, paper 1.5%, mainten 1.0%, flutter 0.9%, safeti 0.9%, oper 0.9%] – *Reliability failures induced by industrial faults with emphasis on the effects of corrosion in these systems.*
- (21) [machin 24.9%, tool 10.3%, cut 8.9%, wear 1.4%, cut.temperatur 1.1%, cryogen.cool 1.1%, surfac.tool 1.0%, surfac 1.0%, rough 1.0%, cryogen 0.8%] – *Various types of machines and machine elements, with emphasis on the effects of tooling, cutting, wear, and temperature (particularly cutting temperature and use of cryogenic cooling).*
- (24) [simul 5.2%, voltag 4.6%, signal 3.4%, mosfet 2.8%, output 2.3%, devic 2.3%, current 2.3%, channel 2.1%, circuit 2.1%, digit 1.7%] – S*imulation of electrical signals and systems (voltage and current relationships) with an emphasis on MOSFET devices.*

- (21) [control 12.7%, current 4.3%, motor 3.2%, feedback 2.8%, actuat 2.8%, scheme 2.7%, speed 2.6%, drive 2.5%, voltag 2.0%, invert 1.9%] – *Controlled electrical systems involving various types of motors, actuators, and feedback schemes.*
- (41) [power 24.1%, system 6.4%, load 2.6%, power.system 2.2%, optim 1.7%, control 1.6%, bu 1.5%, high.power 1.4%, modul 1.3%, output 1.3%] –P*ower systems with emphasis on optimization and control of these systems under different load conditions.*
- (26) [design 31.4%, optim 4.5%, collector 2.0%, optim.design 1.9%, forg 1.7%, cost 1.4%, paper 1.1%, canal 0.7%, mig 0.7%, orthogon 0.6%] – *Optimal designs for both electrical circuits (with emphasis given to the collector node of transistor arrays) and hydrodynamic systems.*
- (22) [optim 17.3%, optim.solut 4.4%, job 3.7%, algorithm 3.5%, solut 3.1%, nsga 2.6%, pareto 2.1%, orthogon 2.0%, arrai 1.8%, orthogon.arrai 1.6%] – *Primarily algorithmic optimization problems (particularly nondominated sorting genetic algorithms, or NSGAs) and proposed solutions, in terms of minimized job processing requirements.*
- (11) [graph 50.6%, algorithm 1.8%, vertic 1.8%, optim 1.7%, disassembl 1.5%, scheme 1.4%, matrix 1.1%, neighbourhood 1.0%, approxim 1.0%, schedul 1.0%] – *Graphs as data storage/manipulation tools (with data arranged as vertices in graphs) with emphasis on optimizing algorithms.*
- (46) [algorithm 46.2%, path 2.2%, queri 2.0%, comput 1.9%, time 1.8%, paper 1.1%, logic 0.8%, bound 0.8%, set 0.7%, system 0.6%] – *Algorithms, with emphasis on path structure, queries, and computing time.*
- (34) [estim 12.2%, nois 7.6%, error 7.1%, data.set 2.9%, time.seri 1.6%, data 1.6%, squar 1.5%, set 1.4%, signal 1.3%, time 1.2%] – *Estimation and practical estimators for extracting useful data and minimizing error in the presence of noise.*

3.1.2. Mathematics, physical systems and modeling, and engineering science

**3.1.2.1. Mathematics, energy, and wave modeling**

- (29) [suffici.condit 4.1%, distribut 3.8%, suffici 3.6%, condit 3.4%, class 2.6%, asymptot 2.5%, code 2.4%, asymptot.stabil 2.1%, distribut.order 1.9%, test 1.8%] – *Sufficient conditions for analyses involving various distribution schemes.*

- (31) [space 15.3%, banach.space 6.6%, banach 6.5%, fix.point 3.6%, compact 3.0%, oper 2.9%, metric 2.7%, converg 2.5%, fix 2.3%, integrodifferenti 1.8%] – *Nature of space, particularly Banach space, with emphasis on fixed points and compactness.*
- (22) [let 14.3%, bundl 7.7%, connect 5.9%, topolog 4.4%, equal 3.5%, space 3.3%, vector 2.5%, set 1.7%, equal.sequenc 1.7%, modulo 1.7%] – *Vector bundles with emphasis on connectivity and topology.*
- (18) [prove 27.1%, modul 10.7%, submodul 2.2%, conjectur 2.2%, project 2.1%, gener 1.9%, theorem 1.7%, solut 1.7%, paper.prove 1.7%, prove.gener 1.4%] – *Proofs involving mathematic modules (systems with scalars coming from a ring) and corresponding submodules.*
- (34) [polynomi 12.0%, algebra 8.9%, represent 4.9%, function 2.7%, construct 2.4%, prime 1.8%, equal 1.6%, ring 1.2%, commut 1.2%, integr 1.1%] – *Polynomials, particularly on constructing algebraic polynomial representations of various systems.*
- (25) [gaug 19.3%, noncommut 11.7%, theori 3.4%, dual 2.3%, invari 1.8%, brst 1.7%, gaug.invari 1.3%, string 1.2%, field 1.1%, hamiltonian 1.0%] – *Gauges, with emphasis on noncommutativity properties and various gauge theories.*
- (23) [string 21.7%, brane 15.1%, theori 11.3%, string.theori 2.0%, dualiti 1.3%, solut 1.1%, construct 1.0%, momenta 1.0%, torsion 1.0%, configur 0.8%] – *Brane cosmology, particularly strings (1-branes) and their associated theories.*
- (31) [field 10.4%, scalar 4.9%, cosmolog 4.6%, scalar.field 3.8%, theori 3.2%, univers 3.2%, bianchi 3.0%, bianchi.type 2.7%, magnet.field 1.5%, matter 1.5%] – *Fields (primarily scalar) and field theory, particularly related to cosmology and with emphasis on bianchi-type space time.*
- (29) [solut 11.2%, equat 6.5%, field.equat 3.6%, fluid 2.9%, space 2.7%, analyt.solut 2.2%, analyt 1.6%, metric 1.6%, theori 1.6%, bianchi 1.5%] – *Analytical solutions to various mathematical and scientific equations with emphasis on field equations in fluids- and space-related analysis.*
- (29) [black.hole 11.5%, black 8.0%, hole 6.5%, collaps 5.2%, spacetim 3.8%, singular 3.1%, gravit 2.1%, univers 2.1%, horizon 1.9%, nake 1.6%] – *Black holes with emphasis on their formation (gravity-induced collapse of matter) and spacetime shape/dimensions.*

- (46) [quantum 40.8%, theori 3.4%, quantum.mechan 2.9%, classic 1.7%, physic 1.3%, mechan 1.1%, quantum.theori 1.1%, model 1.0%, quantum.system 0.8%, univers 0.7%] – *Quantum physics, as compared to classical physics, with emphasis on various theories, models, and systems.*
- (30) [model 8.3%, percol 3.9%, forc 2.9%, dynam 2.5%, solenoid 2.2%, dimens 2.0%, tyre 1.4%, conserv 1.3%, critic 1.2%, three.dimens 1.1%] – *Use of fluid-flow models to assess percolation, forces, and physical dynamics of fluidic systems.*
- (37) [model 34.8%, updat 2.1%, voltag 1.2%, short.channel 1.0%, data 0.9%, updat.model 0.9%, threshold.voltag 0.8%, rock 0.8%, rock.mass 0.7%, equat 0.6%] – *Model updating techniques in microelectronics, with emphasis on short channel effects on voltage measurements in semiconductor physics.*
- (36) [equat 31.7%, kdv 2.3%, solut 2.1%, kdv.equat 1.0%, epsilon 1.0%, differenti.equat 0.9%, type.inequ 0.9%, deriv 0.8%, korteweg.vri 0.7%, vri 0.7%] – *Use of various equations (particularly Korteweg-de Vries, or KdV, equations) to determine solutions rising from primarily differential systems.*
- (24) [boundari 9.2%, scheme 4.5%, numer 3.8%, point.boundari 3.6%, spline 3.1%, two.point 2.9%, two.point.boundari 2.8%, singularli.perturb 2.6%, singularli 2.6%, equat 2.3%] – *Boundary value problems, particularly multi-point BVPs, with emphasis on numerical schemes.*
- (23) [chao 3.8%, order 3.2%, period 3.1%, perturb 2.4%, boundari 2.3%, coupl 2.0%, function.order 1.8%, mode 1.5%, revisit 1.4%, expon 1.3%] – *Transition between order and chaotic behavior with emphasis on the effects of periodic perturbations and/or boundary conditions.*
- (15) [barrier 13.2%, diffus 6.6%, suspens 5.9%, charg 4.7%, diffus.coeffici 1.8%, particl 1.4%, spp 1.3%, superarriv 1.2%, reflect 1.2%, time 1.2%] – *Potential barrier heights with emphasis on diffusion processes, particle charge, and suspension stability*.
- (41) [particl 11.2%, correl 3.0%, correl.function 1.8%, diffus 1.5%, potenti 1.4%, simul 1.3%, motion 1.1%, dynam 0.9%, function 0.9%, self 0.9%] – *Properties of particles, particularly correlation with other properties determined by correlation functions.*
- (40) [wave 39.2%, plasma 7.3%, nonlinear 2.6%, equat 1.7%, instabl 1.5%, amplitud 1.2%, dust 1.1%, frequenc

1.0%, growth.rate 0.6%, acoust 0.6%] – *Behavior of waves in both atmospheric and plasma mediums, using primarily nonlinear equations to model characteristics, such as instability, amplitude, frequency, etc.*

- (25) [mode 14.5%, frequenc 5.0%, normal.mode 2.5%, wave 2.3%, excit 2.3%, scatter 1.7%, normal 1.5%, vibrat 1.5%, state 1.4%, bose 1.3%] – *Modes of vibration (particularly normal modes) as well as frequency modes, with emphasis on wave behavior and excitation principles.*
- (19) [slot 22.3%, apertur 3.4%, coupl 2.1%, mode 1.9%, dome 1.7%, woven.composit 1.3%, respons 1.1%, time.domain 1.1%, rectangular 1.0%, vane 1.0%] – *Slots/apertures used in models with emphasis on corresponding coupling equations.*
- (22) [antenna 43.6%, microstrip 8.8%, patch 3.9%, microstrip.antenna 2.7%, radiat 1.9%, arrai 1.8%, slot 1.6%, patch.antenna 1.2%, reflector 1.0%, bandwidth 1.0%] – *Antennas, particularly microstrip and patch antennas, with emphasis on bandwidth enhancement and radiation characteristics.*
- (27) [star 41.9%, agb 2.8%, dust 2.1%, mass 1.7%, stellar 1.6%, agb.star 1.6%, light 1.5%, spectral 1.2%, bulg 1.0%, post.agb 1.0%] – *Stars, classified by mass as Atomic Giant Branch (agb), non-agb, or post-agb, with emphasis on dust formation and spectral properties.*
- (21) [galaxi 14.0%, emiss 8.9%, disk 6.0%, ga 2.5%, ioniz 1.9%, ngc 1.8%, line 1.4%, dla 1.3%, stellar 1.2%, similar 1.1%] – *Observed behavior of galaxies, with emphasis on emission bands/lines, stellar disks, and ionization.*
- (19) [radio 22.1%, sourc 6.8%, burst 6.0%, flare 2.6%, cosmic 2.3%, jet 2.1%, rai 1.7%, radio.jet 1.3%, optic 1.3%, radio.sourc 1.1%] – *Signals in the radio frequency range including radio sources, cosmic radio bursts and flares, and radio jets.*
- (33) [energi 10.4%, mev 8.2%, neutron 2.2%, beam 2.2%, photon 2.0%, fragment 2.0%, nucleu 1.7%, gamma 1.5%, high.energi 1.5%, nuclear 1.4%] – *Energies (measured in MeV) of atomic and subatomic particles, including neutrons, photon beams, and high-energy gamma rays.*
- (17) [interact 5.0%, interact.energi 2.6%, probabl 2.6%, configur 2.5%, atom 2.3%, pair 1.8%, probabl.configur 1.4%, defect 1.3%, energi 1.3%, comput 1.1%] – *Intermolecular interactions, with emphasis on interaction energies and probable configurations.*

- (34) [cluster 6.1%, atom 5.1%, calcul 4.7%, energi 3.2%, orbit 2.4%, transit 2.2%, correl 1.6%, electron 1.6%, polariz 1.5%, potenti 1.5%] – *Atomic clusters with emphasis on calculating potential energy gaps, electron orbits, and transition states*.
- (23) [free.energi 5.1%, energi 4.8%, 31g 4.6%, function 3.8%, fukui 3.4%, conform 1.8%, free 1.7%, rotat 1.6%, fukui.function 1.6%, vibrat 1.5%] – *Free energies, particularly at the -31g extended basis function level, with emphasis on Fukui functions.*
- (19) [entangl 20.6%, state 19.0%, coher 10.3%, coher.state 6.2%, squeez 4.4%, copi 2.7%, singl.copi 1.0%, state.squeez 0.9%, entangl.state 0.7%, number.copi 0.6%] – *Entanglement properties, with emphasis on coherence- and entanglement states and squeezing properties.*
- (39) [state 12.1%, spin 11.6%, ground.state 8.6%, ground 6.5%, energi 4.9%, excit 2.9%, excit.state 1.2%, system 1.0%, sigma 0.9%, electron 0.9%] – *States of complex systems, particularly ground and excitation states, with emphasis on spin and excitation energies.*
- (24) [cross.section 19.9%, section 15.4%, cross 12.0%, ioniz 5.0%, scatter 2.7%, photon 1.5%, measur 1.3%, differenti.cross 1.1%, differenti.cross.section 1.1%, total.cross 1.0%] – *Cross-section analysis, with emphasis on ionization- and differential cross-sections, and atomic scattering.*
- (32) [gev 22.8%, collis 5.3%, particl 2.0%, hadron 1.9%, boson 1.9%, transvers 1.8%, energi 1.7%, agbr 1.6%, mass 1.5%, mass.energi 1.4%] – *Energy released in particle collisions (in the GeV range), particularly involving hadrons (subatomic particle), and bosons.*
- (14) [meson 12.5%, decai 9.9%, bell.detector 4.4%, bell 3.9%, detector 3.8%, branch.fraction 3.8%, bar 3.8%, psi 3.0%, bell.detector.kekb 2.6%, detector.kekb 2.6%] – *Mesons (class of subatomic particles) with emphasis on decay properties, Belle detector measurements (from the Japanese KEKB), and predictions/determinations of branching fractions.*
- (19) [quark 17.2%, decai 8.3%, tau 3.2%, violat 2.5%, lightest 1.7%, supersymmetr 1.6%, model 1.5%, lepton 1.3%, squark 1.2%, hadron 1.1%] – *Quarks, with emphasis on decay modes/times, the tau ($\tau$) parameter, and various model violations.*
- (32) [neutrino 41.6%, solar 7.1%, mass 2.4%, solar.neutrino 1.8%, sno 1.7%, mix 1.4%, oscil 1.4%, neutrino.mass 1.3%, mix.angl 1.3%, muon 1.1%] –

*Neutrinos, particularly solar neutrinos, emphasizing results coming from SNO (Sudbury Neutrino Observatory).*

**3.1.2.2. Thermo-fluid dynamics science and engineering**

- (20) [circuit 18.5%, wind 4.6%, design 3.5%, engin 2.9%, bifurc 2.6%, fuel 1.8%, experiment 1.3%, humidif 1.3%, flip 1.2%, clock 1.1%] – *Circuit design, with emphasis on wind energy conversion and associated engineering characteristics.*
- (20) [bubbl 8.7%, fuel 5.8%, reactor 3.7%, emuls 2.8%, model 2.1%, pressur 2.0%, channel 1.9%, liquid 1.6%, engin 1.4%, inlet 1.4%] – *Bubble dynamics in liquids, especially fuels, with emphasis on reactors and emulsion techniques.*
- (23) [jet 9.7%, pressur 6.3%, reynold 4.5%, mix 3.2%, turbul 2.1%, ratio 2.0%, reynold.number 2.0%, bear 1.8%, flow 1.6%, journal.bear 1.4%] – *Jets with emphasis on pressure (and pressure ratios), flow dynamics (determined using Reynold's number), and mixing conditions.*
- (43) [flow 45.2%, flow.rate 2.6%, rate 1.4%, turbul 1.4%, fluid 1.1%, model 0.9%, flow.regim 0.9%, simul 0.7%, regim 0.7%, turbin 0.7%] – *Fluid flow with emphasis on flow rate, turbulence, and modeling/simulation.*
- (26) [flow 18.1%, veloc 6.7%, disk 1.9%, constrict 1.9%, magnet 1.9%, wall 1.9%, drag 1.4%, magnet.field 1.3%, accret 1.2%, field 1.1%] – *Fluid flow with emphasis on accretion disks and flow velocity in constricted vessels and/or magnetic fields.*
- (28) [convect 22.3%, veloc 2.8%, fluid 2.6%, field 2.6%, mass.transfer 1.9%, layer 1.8%, magnet 1.7%, magnet.field 1.6%, onset.convect 1.3%, transfer 1.1%] – *Convection and convective fluid flow, with emphasis on flow velocity, effects of physical (mainly magnetic) fields, and mass transfer.*
- (47) [heat 21.4%, heat.transfer 8.2%, transfer 4.8%, flux 3.1%, heat.flux 2.2%, flow 2.0%, fluid 1.8%, temperatur 1.6%, veloc 1.1%, number 0.9%] – *Heat transfer, with emphasis on heat flux and flow properties.*
- (40) [shell 5.6%, element 5.4%, lamin 4.4%, plate 4.3%, finit.element 3.8%, finit 3.0%, vibrat 2.0%, displac 1.7%, shear 1.7%, load 1.6%] – *Plate and shell elements, particularly laminated shells, with emphasis on finite element methods.*
- (25) [crack 22.1%, stress 9.0%, thermoelast 2.0%, load 1.9%, half.space 1.7%, beam 1.7%, displac 1.5%, concret 1.4%, fractur 1.3%, elast 1.0%] – *Stress-induced cracking,*

*with emphasis on thermoelasticity theories, loading, and beam failure.*

- (37) [strength 8.5%, crack 8.2%, epoxi 3.3%, fractur 3.3%, tensil 2.5%, composit 2.4%, compress 2.2%, specimen 1.9%, load 1.7%, compress.strength 1.5%] – *Material strength and failure (cracking), particularly tensile and compressive strength, with emphasis on epoxies and composites.*
- (26) [motion 5.8%, friction 4.8%, bear 4.5%, rigid 3.5%, seismic 3.2%, tank 2.2%, ground.motion 2.1%, thrust 1.9%, wedg 1.8%, ground 1.6%] – *Motion of various (mostly rigid) bodies, particularly involving friction, with emphasis on bearing systems and seismic activity.*
- (13) [yarn 23.0%, yam 18.3%, twist 9.1%, abras 5.3%, spun 2.3%, rotor 2.0%, fibr 1.7%, textur 1.6%, air.jet 1.6%, fabric 1.4%] – *Yarn and associated twisting/spinning systems, with emphasis on abrasion properties and rotor yarns.*
- (13) [wear 36.0%, abras 7.5%, abras.wear 4.7%, slide 3.5%, fibr 2.5%, load 1.9%, composit 1.8%, friction 1.4%, reinforc 1.3%, ball 0.8%] – *Physical wear, particularly abrasive wear and associated sliding properties, with emphasis on fibers and composites.*
- (19) [fibr 43.3%, composit 3.5%, cellulos 1.0%, jute 0.9%, tensil 0.9%, properti 0.9%, reinforc 0.8%, coir 0.8%, jute.fibr 0.7%, fibr.orient 0.6%] – *Fibers and fiber composites, with emphasis on cellulose content and jute fibers.*
- (21) [fiber 44.8%, composit 8.9%, reinforc 2.8%, composit.microspher 1.6%, microspher 0.9%, properti 0.8%, alkali 0.6%, corner 0.6%, pani 0.6%, sisal 0.5%] – *Fibers and fiber composites, with emphasis on reinforcement (fiber and composite) and properties of composite microspheres.*
- (15) [soliton 23.5%, propag 6.9%, puls 4.2%, fiber 2.8%, group.veloc 2.4%, veloc 1.7%, dispers 1.7%, soliton.solut 1.5%, medium 1.4%, ferromagnet.medium 1.4%] – *Properties of solitons (pulselike waves), particularly propagation and (group) velocities.*
- (41) [blend 37.2%, rubber 5.2%, epdm 3.8%, eva 1.8%, nbr 1.6%, composit 1.6%, polym 1.1%, black 1.0%, enr 0.8%, properti 0.8%] – *Material blends, particularly rubber blends, with emphasis on EPDM (ethylene-propylene-diene-monomer), EVA (ethylene vinyl acetate), and NBR (nitrile butadiene rubber).*

3.2. Materials science/film properties

3.2.1. Materials science

### 3.2.1.1. Metal/alloy device physics and engineering

- (26) [implant 7.1%, ion 6.6%, irradi 4.9%, gan 4.0%, layer 3.0%, rai 1.7%, kev 1.6%, surfac 1.4%, ion.implant 1.3%, dose 1.3%] – *Ion implantation, particularly through irriadiation processes, with emphasis on Gallium Nitride (GaN) layers and X-ray emission/diffraction.*
- (30) [current 7.9%, diod 6.0%, schottki 3.6%, charg 3.2%, trap 3.1%, voltag 3.0%, cdte 2.2%, devic 1.9%, passiv 1.9%, interfac 1.7%] – *Current flow, particularly through diodes, with emphasis on Schotkii diodes/barriers, trapped charge, and voltage properties.*
- (23) [current 5.2%, corros 4.1%, cathod 4.0%, anod 3.6%, pit 2.5%, silver 2.5%, dissolut 2.5%, electrod 2.4%, potenti 2.3%, passiv 2.0%] – *Current flow with emphasis on electrochemical properties and flow degradation in anodes and cathods due to corrosion and pitting.*
- (14) [manganes 8.8%, cobalt 6.8%, nickel 5.9%, nickel.cobalt 4.1%, manganes.nodul 2.9%, ocean.manganes 2.7%, ocean.manganes.nodul 2.7%, copper 2.2%, black.coat 1.7%, nodul 1.6%] – *Manganese, particularly its chemical interaction with nickel and cobalt, with emphasis on ocean manganese nodules.*
- (22) [corros 7.2%, steel 6.3%, stainless.steel 3.9%, stainless 3.9%, microstructur 3.2%, strain 3.2%, deform 2.7%, strain.rate 2.5%, cold 1.8%, recrystal 1.6%] – *Effects of corrosion on steel, particularly stainless steel, with emphasis on microstructural features and strain-induced deformation.*
- (20) [weld 26.9%, microstructur 2.6%, heat 2.6%, tube 2.4%, zone 2.3%, tough 1.8%, steel 1.4%, chromium 1.2%, heat.treatment 1.1%, martensit 1.1%] – *Welding and weld heat treatments, with emphasis on microstructural properties.*
- (61) [alloi 57.7%, phase 1.7%, precipit 0.8%, temperatur 0.8%, resist 0.7%, wear 0.7%, composit 0.7%, slide 0.6%, microstructur 0.6%, creep 0.6%] – *Alloys, with emphasis on differing phases, precipitation (and precipitates), and temperature properties.*
- (31) [phase 2.6%, coat 2.5%, fe2o3 2.2%, emitt 1.6%, nitrid 1.4%, temperatur 1.3%, demix 1.2%, rai 1.1%, boron 1.1%, thermal 1.1%] – *Phase behavior, particularly of coated materials, with emphasis on ferric oxide ($Fe_2O_3$), nitrides, and emitter behavior.*
- (24) [sinter 27.9%, powder 7.6%, compact 2.8%, alumina 2.5%, densif 1.8%, mill 1.6%, phase 1.5%, hap 1.2%,

grain 1.2%, powder.compact 1.0%] – *The sintering process, typically applied to powedered materials (esp. alumina), with emphasis on compaction, densification, and milling.*

- (25) [particl 18.3%, size 14.8%, particl.size 5.6%, pore 5.3%, nanoparticl 1.4%, powder 1.4%, eu2o3 1.2%, ce3 1.1%, pore.size 1.1%, size.distribut 0.9%] – *Particle properties, particularly particle size, with emphasis on pore sizes, nanoparticles, and powdered materials.*
- (14) [gel 6.4%, sol 5.1%, whisker 5.1%, sol.gel 3.4%, degreesc 3.0%, zro2 2.7%, powder 2.6%, sicw 2.4%, nanowir 1.6%, phosphor 1.5%] – *Gels, particularly Sol-Gel and its associated synthesis process, with emphasis on whisker formation and reactions involving zirconia ($ZrO_2$) and/or silicon carbides (SiCw).*
- (20) [degrad 9.8%, tio2 2.8%, photocatalyt 2.7%, cellulos 2.6%, oxid 2.2%, reaction 2.0%, photocatalyst 1.9%, mol 1.5%, hydrogen 1.3%, concentr 1.2%] – *Material degradation, particularly titanium oxide ($TiO_2$), with emphasis on photocatalytic activities, cellulose oxidation, and reaction conditions.*
- (26) [oxid 16.6%, decomposit 6.4%, nitrat 4.2%, ammonium 2.1%, acid 1.8%, thermal.decomposit 1.5%, reaction 1.4%, dissolut 1.4%, reagent 1.1%, ammonium.nitrat 0.9%] – *Oxides and oxidation, with emphasis on decomposition and reactions involving various nitrates (esp. amonium nitrate) and acids.*
- (18) [compost 16.0%, flour 6.5%, wheat 5.1%, vermicompost 5.1%, dough 3.2%, chapati 2.6%, fodder 2.4%, starch 2.4%, wheat.flour 1.5%, clai 1.4%] – *Compost/composting (particularly vermicompost), and breadmaking (using wheat flour to make dough).*
- (26) [properti 7.2%, cement 4.6%, gliadin 4.0%, coke 2.6%, strength 2.4%, materi 2.2%, mpb 1.7%, clai 1.6%, lime 1.5%, coal 1.3%] – *Focuses on material properties, particularly strength and stiffness, with emphasis on cement, coke, gliadin, clay, lime, and coal.*
- (28) [thermal 7.6%, stress 6.3%, temperatur 4.3%, thermal.diffus 2.5%, diffus 2.3%, thermal.stress 1.7%, modulu 1.6%, moistur 1.6%, viscos 1.5%, shell 1.4%] – *Temperature-induced (thermal) stress with emphasis on effects of thermal diffusivity, moisture, and viscosity.*
- (22) [heat 13.6%, temperatur 3.1%, monotect 2.2%, moo3 1.9%, boil 1.6%, thermal.cycl 1.3%, degreesc 1.2%, phase 1.0%, intermetal 1.0%, thermal 0.9%] – *Heat, particularly*

*its effects on monotectic reactions, with emphasis on boiling properties and thermal cycles.*

- (26) [pressur 23.1%, gpa 18.7%, high.pressur 3.2%, transit 2.1%, pressur.gpa 1.8%, phase 1.6%, temperatur 1.5%, structur 1.2%, anvil 1.1%, tetragon 1.0%] – *Pressure, particularly very high pressure (order of GPa), and its effect on phase and transition properties.*
- (24) [phase 13.8%, transit 13.1%, phase.transit 4.2%, temperatur 2.6%, smectic 2.5%, isotrop 1.7%, liquid 1.1%, pore 1.1%, lattic 1.0%, flare 0.8%] – *Phase transitions, with emphasis on temperature, smectic, and isotropy effects.*
- (17) [thermal.expans 10.9%, expans 6.1%, temperatur 4.0%, thermal 3.8%, vapor 3.5%, teo2 2.3%, phase 2.0%, 298 1.4%, ceo2 0.9%, mno 0.9%] – *Thermal expansion, with emphasis on tellurium dioxide ($TeO_2$) and other vapors.*

### 3.2.1.2. Electrical/magnetic properties of materials

- (25) [conduct 19.0%, frequenc 4.1%, hop 3.0%, temperatur 3.0%, relax 1.5%, electr 1.5%, omega 1.2%, rang 1.0%, activ.energi 0.9%, agi 0.9%] – *Conductivity, particularly its dependence on frequency and temperature, with emphasis on ion hopping and relaxation characteristics.*
- (25) [relax 23.8%, dielectr 8.8%, relax.time 5.0%, frequenc 2.2%, temperatur 2.2%, permitt 1.9%, liquid 1.4%, time 1.1%, dielectr.relax 1.0%, phase 0.6%] – *Relaxation properties, particularly of dielectric materials, with emphasis on relax times/frequencies and temperature effects.*
- (44) [dielectr 22.5%, dielectr.constant 6.3%, temperatur 4.3%, frequenc 3.6%, constant 3.4%, sinter 3.3%, ferrit 2.6%, composit 2.0%, ceram 1.1%, epsilon 1.0%] – *Properties of dielectric materials, including dielectric constants and effects of temperature and frequency.*
- (38) [glass 51.2%, b2o3 1.3%, ion 1.1%, pbo 1.1%, optic 1.0%, glass.system 0.8%, temperatur 0.7%, transit 0.6%, teo2 0.5%, judd 0.5%] – *Glass, particularly boron oxide ($B_2O_3$) or lead oxide (PbO) glasses, with emphasis on ion concentration and optical characteristics.*
- (33) [pin 5.8%, field 5.7%, magnet 3.8%, superconductor 3.1%, critic 2.3%, cdw 2.2%, vortex 2.2%, magnet.field 2.1%, junction 1.9%, phase 1.9%] –C*rystallographic pinning properties, with emphasis on magnetic field interaction and superconductors.*
- (83) [magnet 39.7%, field 2.9%, ferromagnet 2.7%, spin 2.3%, magnet.field 2.1%, temperatur 1.7%, moment 1.5%,

transit 1.2%, antiferromagnet 1.1%, suscept 0.9%] – *Magnetic properties of materials, particularly ferro- and antiferromagnetic, with emphasis on spin, field, moment, and temperature effects.*

- (31) [dope 8.2%, insul 3.0%, 5mno3 2.3%, transit 2.3%, hop 2.2%, charg.order 2.0%, ferromagnet 1.9%, transport 1.9%, sampl 1.9%, metal 1.5%] – *Doped materials/systems, with emphasis on transitions to/from insulating regime, ion hopping, and charge order.*
- (25) [superconduct 19.7%, plane 2.5%, equal 2.3%, dope 1.8%, neutron.diffract 1.7%, superconductor 1.4%, temperatur 1.4%, hole 1.3%, fluctuat 1.2%, neutron 1.1%] – *Focuses on properties of superconductors, with emphasis on (lattice) planes, effects of doping, and neutron diffraction.*
- (20) [electron 5.7%, photoemiss 4.1%, photoemiss.spectroscopi 2.7%, fermi 2.2%, electron.structur 1.8%, structur 1.8%, temperatur 1.8%, kondo 1.5%, band 1.4%, resolv.photoemiss 1.3%] – *Electron behavior in photoemission spectroscopy, with emphasis on fermi energies and electron structure.*
- (21) [band 5.9%, absorpt 4.7%, zn 3.8%, spectra 3.4%, optic.absorpt 2.7%, gap 2.4%, peak 2.3%, optic 2.3%, phosphor 1.9%, absorpt.spectra 1.9%] – *Energy bands, particularly absorption bands, with emphasis on Zn composites, spectral properties, and optical absorption.*
- (16) [phonon 47.2%, electron.phonon 4.6%, electron 2.2%, phonon.coupl 2.0%, electron.phonon.coupl 1.6%, temperatur 1.4%, phonon.mode 1.2%, phonon.interact 1.1%, raman 0.9%, mode 0.9%] – *Phonons, with emphasis on electron-phonon interaction and electron-phonon coupling.*

3.2.2. Film properties

### 3.2.2.1. Thin film deposition

- (27) [film 11.8%, substrat 3.6%, ybco 3.4%, temperatur 3.3%, thin.film 2.2%, superconduct 2.1%, ghz 1.8%, peak 1.8%, thin 1.7%, microwav 1.6%] – *Films applied onto substrates, particularly thin $YBa_2Cu_3O_7$ (i.e. YBCO) films, with emphasis on temperature and superconductor physics.*
- (33) [film 18.8%, thin.film 15.3%, thin 13.6%, deposit 1.7%, antiferroelectr 1.1%, sensor 1.0%, optic 0.9%, ferroelectr 0.8%, temperatur 0.7%, laser 0.7%] – *Thin films and thin film deposition, primarily for optical sensors, with emphasis on ferroelectric/antiferroelectric properties.*
- (98) [film 49.9%, deposit 4.6%, substrat 2.8%, thin.film 2.1%, thin 1.7%, anneal 1.3%, optic 1.2%, sputter 1.0%,

temperatur 0.8%, film.deposit 0.8%] – *Film properties and deposition onto substrates, with emphasis on thin films, sputter deposition, and annealing.*

**3.2.2.2. Film deposition in photovoltaic/solar cells**

- (28) [film 18.1%, deposit 5.1%, amorph 2.6%, muc 2.2%, silicon 2.1%, hydrogen 1.7%, plasma 1.3%, chemic.vapor 1.1%, chemic.vapor.deposit 1.1%, microcrystallin 1.1%] – *Films and deposition techniques, with emphasis on amorphous materials, hydrogenated microcrystalline silicon ($\mu$c-Si:H) films (as used in photovoltaic/solar cells), and plasma- and chemical vapor deposition.*
- (27) [deposit 8.3%, silicon 4.2%, solar.cell 4.1%, carbon 2.5%, cell 2.4%, solar 2.1%, anneal 2.0%, lpv 1.9%, gold 1.5%, adhes 1.4%, waveguid 1.1%] – *Focuses on deposition of various materials (esp. onto silicon), with emphasis on solar cell applications.*

4. Medical and biological sciences
   4.1. Biological/life sciences
      4.1.1. Biomolecular analysis

**4.1.1.1. Structure of molecular complexes**

- (31) [crystal 30.7%, singl.crystal 5.4%, grown 4.8%, dope 3.6%, singl 2.1%, temperatur 1.8%, crystal.grown 1.6%, grown.crystal 1.5%, singl.crystal.grown 0.8%, tg 0.7%, switch 0.7%] – *Crystal structures, with emphasis on grown single-crystals and doped crystalline materials.*
- (21) [crystal 28.7%, compound 2.9%, structur 1.8%, grown 1.5%, dba 1.3%, crystal.growth 1.2%, dimension 1.0%, growth 0.9%, avrami 0.8%, space.group 0.8%] – *Crystal structures, with emphasis on compound structures and crystal growth.*
- (28) [angstrom 52.4%, degre 4.3%, crystal 2.3%, angstrom.beta 1.9%, monoclin 1.5%, space.group 1.5%, beta.degre 1.3%, beta 1.1%, 293 1.0%, structur 0.8%] – *Crystal lattice physical properties, measured in Angstroms and degrees, with emphasis on monoclinic systems.*
- (24) [ring 21.9%, titl 3.7%, molecul 2.1%, structur.stabil 2.1%, chair 2.0%, conform 1.8%, bond 1.8%, titl.compound 1.8%, crystal 1.7%, crystal.structur 1.5%] – *Molecular rings, with emphasis on structural stability, chair conformation, and bonding properties.*
- (61) [bond 18.1%, hydrogen.bond 13.1%, hydrogen 11.3%, molecul 3.7%, crystal 2.5%, atom 1.7%, structur 1.5%, compound 1.2%, group 1.1%, titl 0.9%] – *Molecular bonding, particularly hydrogen bonding, with an emphasis on crystalline and atomic structures.*

- (33) [complex 24.2%, dna 3.1%, bind 2.5%, endohedr 1.5%, sak 1.0%, energi 1.0%, activ 1.0%, acid 0.9%, activ.complex 0.9%, bond 0.8%] – *Biomolecular complexes, such as DNA, with emphasis on binding energies as well as endohedral and staphylokinsae (SAK) complexes.*
- (22) [complex 15.5%, ligand 10.4%, stabil.constant 4.4%, mix.ligand 3.9%, constant 2.6%, c7h4ns2 2.2%, mix 2.0%, ligand.complex 2.0%, phen 1.8%, ionic.strength 1.6%] – *(Mostly mixed) ligand complexes with emphasis on stability constants and ionic strength.*
- (47) [complex 16.3%, ligand 7.1%, bridg 5.7%, clo4 2.9%, bpy 2.0%, eta 2.0%, pph3 2.0%, structur 1.2%, iii 0.9%, pyridin 0.8%] – *Ligand complexes, with emphasis on bridging ligands and molecular structure.*
- (62) [complex 42.6%, h2o 5.2%, coordin 2.9%, copper 1.4%, ligand 1.1%, copper.complex 1.1%, bi 1.1%, geometri 1.0%, structur 0.9%, decomposit 0.9%] – *Complexes, particularly those containing $H_2O$, with emphasis on coordinated molecules, ligands, and copper complexes.*
- (31) [schiff 13.2%, schiff.base 11.7%, complex 8.8%, base 6.5%, ligand 4.9%, pph3 2.2%, bi 1.4%, complex.schiff.base 1.2%, complex.schiff 1.2%, metal 1.2%] – *Schiff bases and their complexes, with emphasis on ligand complexes.*
- (47) [complex 11.3%, ligand 8.9%, chelat 2.9%, metal 2.6%, element 2.3%, spectral 1.8%, magnet 1.8%, molar.conduct 1.7%, basi.element 1.3%, iii 1.3%] – *Complexes, particularly ligands and chelates, with emphasis on metal interaction and electronic spectral properties.*
- (22) [complex 5.6%, spectra 5.1%, nmr 4.8%, element 1.5%, spectral 1.2%, complex.type 1.2%, alpha 1.1%, salicylaldehyd 0.9%, element.conduct 0.9%, molar 0.8%] – *Complexes and associated spectral studies, with emphasis on nuclear magnetic resonance (NMR) studies.*
- (13) [opri 32.0%, benzen 5.6%, opri.opri 3.7%, iii 2.9%, molar.ratio 2.3%, deriv 2.1%, molecular.weight 1.4%, molar 1.4%, nmr 1.3%, molecular.weight.measur 1.1%] – *OPRI, the first isoform of OPR (12-oxophytodienoate 10,11-reductose), with emphasis on benzene reactions, molar ratios, and molecular weight.*

#### 4.1.1.2. Compounds/compound synthesis

- (33) [spectral 7.2%, spectral.data 6.3%, nmr 3.9%, nmr.mass 3.8%, compound 3.1%, synthes 2.5%, nmr.mass.spectral 2.2%, mass.spectral 2.2%, data 2.2%, aryl 2.0%] – *Spectral data measurements, particularly*

*NMR and mass spectral data, with emphasis on synthetic compounds.*

- (27) [compound 8.0%, antibacteri 6.6%, screen.antibacteri 4.0%, triazolo 3.9%, compound.screen 3.7%, screen 3.7%, triazol 3.4%, antifung 3.0%, compound.screen.antibacteri 2.1%, substitut 2.1%] – *Antibacterial and antifungal activity in compounds, particularly screening for such activity*
- (46) [compound 44.0%, activ 2.9%, substitut 1.7%, synthes 1.3%, titl 1.2%, titl.compound 1.0%, deriv 0.9%, condens 0.9%, antimicrobi 0.8%, nmr 0.7%] – *General compounds, with emphasis on various types of activity including substitution and compound synthesis.*
- (22) [compound 13.7%, new.compound 5.1%, new 2.9%, betulin 2.8%, acid 1.8%, heterocycl 1.8%, two.new.compound 1.6%, two.new 1.5%, beta 1.5%, heterocycl.compound 1.4%] – *New compounds, particularly those involving betulin and/or betulinic acid, with emphasis on heterocyclics.*
- (25) [beta 4.7%, elucid 4.1%, structur.elucid 4.0%, isol 4.0%, 3beta 3.2%, spectral 2.9%, flavon 2.7%, new 2.5%, chemic 2.3%, dihydroxi 2.2%] – *Structural elucidation of various molecules, particularly isolated compounds.*
- (20) [methyl 23.8%, tetracycl 4.3%, hydroxi 3.8%, methoxi 3.4%, benzo 2.1%, acid 1.5%, phenoxi.phen 1.4%, methoxi.methyl 1.2%, phenoxi 1.1%, hydroxi.methyl 1.1%] – *Organic molecules, particularly those containing the hydrocarbon $CH_3$ (methyl-), with emphasis on chemical structure.*
- (23) [phenyl 35.7%, pyrazolin 4.3%, pyrazolin.on 3.0%, phenyl.pyrazolin 2.5%, methyl 2.1%, methyl.phenyl 2.0%, cure 1.9%, oxo 1.8%, phenyl.pyrazolin.on 1.7%, amin 1.6%] – *Organic molecules, particularly those containing the hydrocarbon $C_6H_5$ (phenyl-), with emphasis on curing.*
- (22) [substitut 7.6%, qsar 3.0%, mesomorph 2.6%, phenyl 2.5%, seri 1.9%, ring 1.7%, relationship.qsar 1.7%, activ.relationship.qsar 1.7%, quantit.structur.activ 1.7%, quantit.structur 1.7%] – *Substitution in organic molucules, particularly in quantitative structure activity relationships (QSARs), with emphasis on mesomorphic properties, and molecules containingring structures and/or phenyl- groups.*
- (40) [synthesi 26.0%, alkaloid 5.2%, yield 1.9%, tert 1.6%, substitut 1.5%, imin 1.5%, bromo 1.3%, cyclophan 1.3%, solid 1.2%, on.step 1.1%] – *Synthesis of molecules, particularly alkaloids, with emphasis on yield.*

- (45) [synthesi 26.1%, stereoselect 5.1%, kei 2.5%, total.synthesi 2.4%, stereoselect.synthesi 1.7%, scienc 1.6%, step 1.6%, diamin 1.5%, kei.step 1.5%, chiral 1.5%] – S*ynthesis of molecules with emphasis on stereoselective synthesis (compared with total synthesis).*
- (33) [synthesi 4.9%, adduct 3.8%, on.pot 3.6%, aryl 3.3%, pot 2.8%, reaction 2.2%, build.block 2.2%, bayli 2.1%, bayli.hillman 2.1%, hillman 2.1%] – *Synthesis of molecules, with emphasis on adducts and one-pot syntheses/reactions.*
- (34) [alpha 11.3%, beta 10.3%, ester 6.6%, peptid 2.6%, acid 2.3%, cyclodextrin 2.0%, synthesi 1.8%, alpha.beta 1.7%, anhydrid 1.5%, unsatur 1.3%] – *Organic molecules, particularly alpha- and beta- anomers, with emphasis on esters, peptides, and acids.*
- (32) [cycloaddit 15.9%, reaction 8.0%, afford 4.9%, dipolar.cycloaddit 3.2%, dipolar 3.0%, cycloaddit.reaction 2.4%, aryl 1.9%, ylide 1.7%, carbonyl 1.6%, carbonyl.ylide 1.4%] – *Cycloaddition reactions, particularly those that afford compounds of interest, with emphasis on dipolar cycloaddition.*
- (38) [afford 21.2%, afford.correspond 10.8%, yield 5.4%, yield.high 3.5%, correspond 3.4%, react.smoothli 2.2%, smoothli 2.0%, high 2.0%, condit.afford 2.0%, react 1.7%] – *Reactions that afford high yields of corresponding compounds, with emphasis on smooth reactions.*
- (30) [amin 6.3%, yield 4.7%, benzopyran 4.5%, chromon 2.6%, correspond 2.3%, on 2.2%, prop 2.0%, benzopyran.on 1.9%, reduct 1.7%, quinolin 1.6%] – *Amines and benzopyran, while discussing other organic compounds, with emphasis on yield.*
- (29) [aromat 9.2%, aldehyd 5.9%, substitut 4.1%, condens 3.2%, reaction 3.0%, aromat.aldehyd 2.0%, microwav 2.0%, deriv 1.8%, microwav.irradi 1.8%, electrophil 1.8%] – *Aldehydes and aromatic organic compounds, with emphasis on substitution and condensation reactions.*
- (31) [allyl 10.4%, acet 5.0%, ether 3.3%, carbonyl 3.2%, yield 3.0%, carbonyl.compound 2.5%, high.yield 1.6%, regioselect 1.5%, aryl 1.4%, alcohol 1.4%] – *Allyls ($C_3H_5$), with emphasis on ethers and acetyl and carbonyl compounds.*
- (28) [solvent.free 11.3%, microwav 9.8%, irradi 6.0%, microwav.irradi 6.0%, solvent 4.2%, solvent.free.condit 2.8%, free 2.5%, free.condit 2.4%, condit 1.9%, yield 1.8%] – *Solvent-free methods/conditions, with emphasis on microwave irradiation.*

4.1.2. Animal and earth sciences/botany

**4.1.2.1. Biochemistry and animal biology studies**

- (61) [catalyst 54.0%, reaction 1.6%, catalyt 1.4%, oxid 1.3%, select 1.2%, acid 0.9%, activ 0.8%, support 0.7%, olefin 0.5%, epoxid 0.4%] – *Catalysts and corresponding catalytic reactions, with emphasis on oxidation and selectivity*.
- (23) [zeolit 12.0%, select 6.8%, toluen 4.2%, reaction 2.7%, alkyl 2.6%, methan 2.0%, convers 1.7%, para 1.7%, benzoyl 1.6%, catalyst 1.6%] – *Zeolites, with emphasis on selectivity properties as well as reactions involving toluene ($CH_3C_6H_5$).*
- (18) [mcm 7.7%, ceo2 6.5%, oxid 3.7%, mesopor 3.2%, surfac.area 2.4%, vanadia 2.3%, la2o3 2.3%, tio2 2.3%, catalyt 2.2%, xrd 1.7%] – *Mesoporous crystalline materials (MCMs) as well as cerium oxide ($CeO_2$) compounds, with emphasis on the effects of surface area.*
- (55) [rate 10.2%, reaction 7.3%, kinet 4.4%, oxid 4.1%, order 3.0%, constant 2.8%, acid 2.1%, first.order 2.0%, activ.paramet 1.9%, step 1.8%] – *Rates of chemical processes, particularly reaction rates and oxidation rates, with emphasis on kinetics.*
- (34) [reaction 12.2%, lactic 3.9%, lactic.acid 3.2%, kinet 2.8%, acid 2.3%, rate 2.0%, salt 1.7%, mol 1.2%, kappa 1.2%, phase 1.0%] – *Chemical reactions, particularly those involving lactic acid, with emphasis on kinetics.*
- (18) [lipas 24.9%, alcohol 10.4%, cepacia 2.9%, immobil 2.9%, transesterif 1.9%, cepacia.lipas 1.7%, pseudomona.cepacia 1.3%, esterif 1.3%, secondari.alcohol 1.1%, enantioselect 1.1%] – *Lipases, particularly from (Pseudomonas) cepacia, with emphasis on alcohol interaction and lipase immobility.*
- (24) [proteas 17.0%, cultur 3.5%, inhibit 2.5%, filtrat 2.2%, activ 1.9%, lipas 1.7%, product 1.7%, purifi 1.7%, venom 1.7%, cystein 1.6%] – *Proteases with emphasis on culture conditions, inhibitors, and filtrate composition.*
- (36) [enzym 37.8%, activ 4.0%, purifi 2.9%, purif 1.7%, enzym.activ 1.4%, degreesc 1.3%, amylas 0.9%, kda 0.7%, chromatographi 0.7%, gel 0.7%] – *Various enzymes, particularly amylases, with emphasis on activity and purification.*
- (19) [enzym 12.8%, immobil 8.6%, sucras 8.2%, oxidas 5.2%, immobil.enzym 3.0%, cellobias 2.9%, activ 1.7%, phb 1.3%, galactos 1.2%, galactos.oxidas 1.1%] – *Enzymes, particularly sucrase (invertase) and oxidase, with emphasis on immobilization.*

- (23) [enzym 5.4%, reaction 4.2%, product 2.9%, exchang 2.6%, biocomposit 2.2%, format 1.5%, photoreduct 1.4%, comet 1.4%, biocomposit.film 1.3%, film 1.2%] – *Enzyme reactions, with emphasis on exchange characteristics, formation of biocomposites, and photoreduction.*
- (21) [unfold 9.8%, denatur 3.9%, stabil 3.0%, fluoresc 2.4%, urea 2.0%, monolay 1.9%, enzym 1.8%, molecul 1.6%, an 1.5%, vat 1.2%] – *Denaturation, or structural unfolding, of various proteins, with emphasis on stability implications.*
- (28) [oil 45.1%, essenti.oil 8.3%, essenti 4.3%, sucker 1.9%, hydrodistil 1.5%, aerial 1.1%, constitu 1.1%, neem 1.0%, aerial.part 0.9%, seed 0.6%] – *Various oils, particularly essential (plant) oils, with emphasis on hydrodistillation, sucker and aerial parts analysis, and constituent characterization.*
- (17) [dye 68.0%, wool 1.1%, reactiv.dye 0.7%, reactiv 0.7%, fluoresc 0.6%, photovoltag 0.6%, algal 0.5%, electron.transfer 0.5%, shade 0.5%, photoinduc 0.4%] – *Dyes, particularly reactive dyes, with emphasis on wool affinity.*
- (15) [radic 32.9%, ampi 4.4%, adduct 3.5%, puls.radiolysi 3.1%, radiolysi 2.9%, reaction 2.9%, puls 1.4%, electron 1.2%, free.radic 1.1%, cluster 0.9%] – *(Free) radicals and associated reactions, particularly those involving aminopyridine (AmPy), with emphasis on adducts and pulse radiolysis.*
- (15) [graft 20.6%, copolyperoxid 6.1%, copolymer 5.2%, reactiv.ratio 4.0%, monom 2.5%, reactiv 2.4%, copolym 2.4%, mma 1.2%, mba 1.1%, inden 1.0%] – *Grafting, particularly graft copolymerization, with emphasis on copolyperoxides and reactivity ratios.*
- (26) [copolym 37.3%, reactiv.ratio 2.4%, kelen 1.8%, tudo 1.6%, kelen.tudo 1.6%, radic 1.5%, copolym.composit 1.4%, nmr 1.4%, acryl 1.1%, reactiv 1.0%] – *Copolymers, with emphasis on reactivity ratios and the Kelen-Tudos (KT) method.*
- (79) [surfact 35.5%, aggreg 6.0%, sd 4.2%, interact 1.2%, cloud 1.2%, cloud.point 1.2%, hydrophob 1.1%, micel 1.0%, nonion 0.9%, tabr 0.8%] – *Surfactants, particularly sodium dodecyl sulfate (SDS), with emphasis on aggregation processes and cloud points.*
- (26) [micel 32.0%, solvat.dynam 4.1%, micellar 3.8%, solvat 3.6%, sd 1.9%, dynam 1.6%, tn 1.4%, ctab 1.3%, surfact 1.1%, triton.100 1.1%] – *Micelles (molecular*

*agglomerates) with emphasis on solvation dynamics and the surfactant SDS.*

- (24) [excit 9.1%, fluoresc 8.3%, state 5.0%, excit.state 2.5%, laser 1.8%, dissoci 1.6%, absorpt 1.5%, transfer 1.3%, emiss 1.2%, nonlinear.suscept 1.2%] – *Excitation and excited states, with emphasis on fluorescence characteristics, lasers, and dissociation.*
- (24) [solvent 32.2%, polar 2.1%, quench 2.0%, solvent.polar 2.0%, water 1.6%, acetonitril 1.4%, wax 1.4%, solvat 1.3%, crystal 1.1%, ethanol 1.1%] – *Solvents, with emphasis on polarity and quenching processes.*
- (20) [electrolyt 3.7%, viscos 3.1%, mixtur 2.4%, chlorid 2.2%, solut 2.1%, water 1.8%, soap 1.4%, methanol 1.4%, molar 1.4%, solvat 1.3%] – *Electrolytes and their properties, with emphasis on viscosity, mixtures/solutions, and chlorides.*
- (19) [mixtur 7.7%, excess 7.4%, binari 4.6%, binari.mixtur 3.2%, ultrason 2.2%, free.length 2.0%, volum 1.8%, liquid.mixtur 1.5%, isentrop 1.4%, molar 1.4%] – *Focuses on mixtures, particularly binary mixtures, with emphasis on excess properties, ultrasonic velocity, and free-length theory.*
- (39) [polym 31.8%, conduct 2.6%, pmma 2.3%, electrolyt 2.0%, polyanilin 1.4%, salt 1.4%, polymer 1.1%, microspher 1.1%, solvent 0.9%, poli 0.9%] – *Polymers/polymerization, particularly polymethylmethacrylate (PMMA), with emphasis on conductivity and electrolytes.*
- (33) [poli 6.1%, polym 3.5%, chain 2.6%, thermal 1.8%, thiophen 1.5%, polymer 1.5%, ftir 1.4%, spacer 1.4%, styren 1.3%, mesogen 1.2%] – *Polymers/polymerization, with emphasis on chain structure and thermal properties.*
- (24) [resin 11.3%, ipn 5.4%, crosslink 4.9%, swell 3.8%, hydrogel 2.8%, polym 2.1%, peg 1.2%, releas 1.2%, sorption 1.1%, hema 1.0%] – *Resins, with emphasis on interpenetrating polymer networks (IPNs), crosslinking, and swelling.*
- (20) [membran 28.0%, polymer 7.1%, separ 1.7%, api 1.6%, graft 1.3%, molecular.weight 1.2%, methacryl 0.9%, flux 0.8%, polym 0.8%, select 0.8%] – *Membranes, particularly polymeric membranes, with emphasis on separation behavior and alkaline protease inhibitors (APIs).*
- (26) [carbon 16.3%, remov 7.1%, phenol 6.5%, activ.carbon 5.7%, adsorpt 4.6%, adsorb 2.3%, surfac 1.6%, activ 1.4%, gac 1.2%, pore 1.2] – *Carbon and carbon complexes (particularly phenol, with emphasis on*

*removal processes, activated carbon, and adsorption properties.*

- (43) [adsorpt 45.2%, adsorb 11.9%, remov 2.9%, langmuir 1.4%, isotherm 1.0%, dye 1.0%, concentr 0.9%, freundlich 0.7%, desorpt 0.6%, activ.carbon 0.5%] – *Adsorption properties for various substances, with emphasis on removal processes and Langmuir and Freundlich models/isotherms.*
- (36) [corros 16.9%, inhibitor 8.9%, steel 4.7%, inhibit 4.2%, inhibit.effici 3.4%, mild.steel 3.3%, adsorpt 2.2%, acid 1.9%, potentiodynam 1.9%, mild 1.9%] – *Corrosion and corrosion inhibitors, particularly in relation to steel, with emphasis on inhibition efficiency (IE) and mild steel (MS).*
- (19) [dose 6.9%, radiat 6.9%, irradi 5.9%, protect 4.2%, damag 2.5%, neurotox 2.3%, induc 2.3%, dose.level 1.9%, radiat.induc 1.5%, triphala 1.4%] – *Radiation dose-dependent systems, with emphasis on radiation damage protection and neurotoxicity.*
- (25) [drug 11.4%, skin 3.2%, anti.inflammatori 2.4%, tuftsin 2.3%, indomethacin 2.2%, nimesulid 2.0%, inflammatori 1.9%, nsaid 1.6%, permeat 1.6%, dosimet 1.3%] - *Effects of drugs, particularly non-sterile anti-inflammatory drugs (NSAIDs), with emphasis on skin response, the tetrapeptide tuftsin, and the NSAID indomethacin.*
- (22) [releas 14.7%, drug 13.4%, tablet 11.0%, gum 6.0%, drug.releas 3.3%, guar.gum 3.1%, guar 3.1%, formul 1.6%, disintegr 1.3%, colon 1.2%] – *Release profiles of drugs, particularly those in tablet form, prepared with a guar gum thickener/stabilizer.*
- (47) [mug 6.6%, beer.law 4.8%, beer 4.7%, spectrophotometr 4.7%, absorpt 3.1%, pharmaceut 3.1%, obei 2.8%, law 2.7%, colour 2.2%, law.obei 1.8%] – *Absorption properties, particularly those determined by Beer's Law (with concentration typically measured in units of mugs/mL), with emphasis on spectrophotometric methods.*
- (22) [chromatograph 4.1%, intern.standard 2.2%, mobil.phase 2.2%, mug 2.0%, detect 1.9%, liquid.chromatograph 1.9%, column 1.8%, hplc 1.7%, precis 1.5%, revers.phase 1.5%] – *Chromatographic methods, with emphasis on internal standards (ISs), mobile phases, and detection properties.*
- (16) [mug 4.6%, standard 2.4%, naphthalen 2.3%, differenti.puls 2.3%, detect.limit 2.1%, uranium 2.0%, deviat 1.9%, nitrit 1.8%, standard.deviat 1.8%, limit 1.7%] – *Use of naphthalene ($C_{10}H_8$) in various processes,*

*with emphasis on concentration levels (in terms of mugs) along with standard deviations, differential pulse polarography, and detection limits.*

- (24) [nanoparticl 7.2%, gold 4.8%, gold.nanoparticl 3.5%, copper 1.7%, solut 1.7%, ion 1.7%, chloroform 1.6%, pi 1.5%, mah 1.4%, hydroxid 1.3%] – *Various nanoparticles, particularly gold nanoparticles, with emphasis on copper nanocomposites, solution properties, and ion behavior.*
- (56) [extract 35.6%, cyanex 3.0%, separ 2.5%, iii 2.1%, acid 1.7%, metal 1.4%, strip 1.4%, 923 1.1%, mol 1.1%, ion 1.0%] – *Extraction techniques/behaviors, particularly those involving the extractant Cyanex®, with emphasis on separation procedures.*
- (58) [extract 34.6%, activ 4.8%, fraction 3.6%, methanol 3.2%, leav 1.5%, methanol.extract 1.4%, chloroform 0.9%, hexan 0.7%, mutagen 0.7%, antibacteri 0.7%] – *Extraction (particularly methanolic extraction) methods, with emphasis on resultant activity and fractionation.*
- (30) [peroxid 5.7%, sod 5.2%, lipid.peroxid 4.3%, radic 4.0%, lipid 3.5%, scaveng 3.3%, antioxid 2.7%, extract 2.4%, activ 2.3%, induc 2.2%] – *Peroxidation and various peroxides, particularly lipid peroxides, with emphasis on superoxide dismutase (SOD), (free) radical scavenging, and antioxidants.*
- (46) [rat 5.5%, glutathion 5.3%, liver 3.9%, antioxid 3.6%, level 2.4%, kidnei 2.0%, oxid.stress 1.6%, treat 1.5%, lipid 1.4%, lipid.peroxid 1.3%] – *Experimental studies involving rats, with emphasis on the functions of glutathione and antioxidants in liver and kidney issues.*
- (23) [sperm 14.7%, vitamin 2.7%, dose 2.6%, chromosom 2.1%, aberr 2.1%, genotox 2.0%, chromosom.aberr 1.7%, cell 1.7%, damag 1.4%, mice 1.4%] – *Sperm production and motility, with emphasis on the effects of vitamin intake (in varying doses), chromosomes and chromosomal aberrations, and genotoxicity.*
- (22) [mice 18.7%, tumour 3.4%, implant 2.4%, ultrasound 1.9%, anim 1.8%, exposur 1.8%, dose 1.6%, treat 1.4%, benzoflavon.moieti 1.4%, cell 1.3%] – *Experimental studies involving mice, with emphasis on tumors, chemical implantation, and ultrasound studies.*
- (28) [dose 5.9%, u50 4.5%, arginin 2.8%, induc 2.5%, treatment 2.1%, receptor 1.7%, administr 1.6%, gaba 1.6%, analgesia 1.4%, convuls 1.3%] – *Dose-dependent responses, particularly those involving U50,488H (U50) and/or argenine, with emphasis on induced reactions and treatment methods.*

- (33) [rat 39.4%, calcium 1.6%, treat 1.5%, serum 0.9%, sex 0.8%, treat.rat 0.7%, cell 0.7%, oxal 0.6%, treatment 0.6%, feed 0.6%] – *Laboratory studies involving rats, with emphasis on calcium levels, rat serum, and treatment methods.*
- (21) [goat 8.6%, follicl 4.1%, mug 3.2%, prolactin 3.0%, oviduct 2.3%, weight 2.1%, bodi 1.6%, dai 1.6%, thyroxin 1.4%, fsh 1.4%] – *Goats, mostly female, with emphasis on ovarian follicles, prolactin, and oviduct activity.*
- (13) [dmba 10.5%, anim 8.6%, fatti 6.7%, fatti.acid 6.1%, lipid 1.9%, garlic 1.9%, poison 1.8%, acid 1.7%, sac 1.6%, hamster 1.5%] – *The hydrocarbon 7,12-dimethylbenz[a] anthracene (DMBA), particularly in relation to various animals, with emphasis on interactions with fatty acids and lipids.*
- (44) [diet 9.1%, group 7.7%, fed 4.5%, dietari 3.7%, digest 3.5%, intak 3.0%, feed 2.8%, supplement 2.5%, calv 2.2%, protein 2.1%] – *Diets and dietary patterns in various (primarily animal) groups, wich emphasis on digestion, intake/feeding patterns, and supplementation.*
- (18) [diabet 15.7%, rat 8.0%, glucos 7.8%, insulin 4.6%, diabet.rat 3.2%, stz 2.9%, neuron 2.5%, induc.diabet 2.4%, plasma.glucos 2.2%, alloxan 2.0%] – *Diabetes, particularly through experimentation on diabetic rats, with emphasis on glucose and insulin levels, streptozotocin (STZ) (as a means of inducing diabetes in animals), and neuron behavior.*
- (17) [diabet 24.0%, patient 6.2%, mmdm 5.8%, iddm 4.9%, gad65 4.4%, mellitu 3.5%, diabet.mellitu 3.3%, type.diabet 3.3%, autoimmun 3.1%, autoantibodi 2.7%] – *Diabetes in humans, with emphasis on malnitrition-modulated diabetes mellitus (MMDM), insulin-dependent diabetes mellitus (IDDM), and glutamate decarboxylase 65 (GAD65).*
- (79) [cell 55.4%, cultur 1.7%, activ 0.9%, growth 0.8%, cell.line 0.6%, express 0.6%, inhibit 0.5%, human 0.4%, cytotox 0.4%, tumor 0.4%] – *Various types of cells, with emphasis on culture properties, cell activity, and cell growth.*
- (22) [membran 9.7%, cell 4.1%, bird 3.5%, cholera 2.9%, hbn 2.6%, estrogen 1.6%, islet 1.4%, receptor 1.4%, assai 1.3%, aspart 1.2%] – *Membranes, particularly cell membranes, with emphasis on bird experimentation, cholera studies, and dimeric haemoglobin (HbN).*

- (15) [ca2 15.0%, atpas 9.5%, membran 4.1%, atpas.activ 3.9%, digoxin 2.5%, activ 2.4%, ca2.atpas 1.7%, hemispher 1.6%, domin 1.4%, hemispher.domin 1.4%] – *The Ca(2+) ion, with emphasis on ATPase activity, effects of membrane behavior, and the ATPase inhibitor digoxin.*
- (32) [apoptosi 7.3%, cell 3.7%, caspas 3.6%, express 2.6%, mapk 2.5%, macrophag 2.4%, activ 2.3%, kinas 2.0%, insulin 1.9%, tubulin 1.6%] – *The process of apoptosis (disintegration of cells), with emphasis on caspase activation, expression, and role of mitogen activated protein kinases (MAPK).*
- (40) [protein 34.4%, kda 8.6%, kinas 5.1%, phosphoryl 3.3%, fraction 0.8%, allergen 0.7%, inhibit 0.7%, kda.protein 0.5%, polypeptid 0.5%, gel 0.5%] – *Proteins (mol. weight measured in kDa), with emphasis on kinase inhibitors and phosphorylation.*
- (28) [antibodi 8.7%, bind 8.2%, protein 6.4%, mab 1.8%, immun 1.7%, gst 1.7%, testi 1.6%, peptid 1.6%, antigen 1.6%, epitop 1.6%] – *Focuses on antibodies in carrier proteins, particularly monoclonal antibodies (MAbs) and anti-GST antibodies, with emphasis on binding properties and immunization.*
- (29) [cell 8.1%, immun 5.2%, antigen 4.8%, anthrax 3.1%, respons 2.6%, ep 2.2%, tumor 1.9%, lethal 1.7%, immun.respons 1.7%, toxin 1.5%] – *Cell response to various antigens, particularly anthrax, with emphasis on immunization and extracellular polymeric substances (EPS).*
- (33) [peptid 16.8%, residu 5.7%, helic 4.5%, beta 4.3%, turn 3.7%, helix 3.3%, structur 3.2%, beta.turn 2.5%, conform 2.3%, protein 1.8%] – *Peptides, particularly those having helical structures, with emphasis on residue occurrence, beta-turns, and conformation.*
- (38) [conform 11.3%, bind 10.8%, structur 2.4%, dna 1.9%, molecul 1.7%, gm1 1.6%, duplex 1.5%, base 1.5%, proton 1.1%, hairpin 1.0%] – *Conformation and binding properties of biomolecular complexes, particularly DNA, with emphasis on structural arrangement.*
- (23) [dna 43.5%, sequenc 2.6%, dna.bind 2.2%, genom 1.7%, bind 1.5%, methyltransferas 1.5%, plasmid 1.3%, amino 1.1%, protein 1.0%, amino.acid 0.9%] – *DNA, with emphasis on sequence analysis, binding properties, and complete genomes.*
- (41) [gene 12.2%, protein 7.6%, sequenc 6.5%, express 5.4%, transcript 3.8%, coli 2.5%, rna 1.7%, amino.acid 1.7%, mutat 1.5%, encod 1.4%] – *Genes, with emphasis on*

*proteins, sequence analysis, expression factors, and transcription.*

- (26) [gene 24.7%, genom 3.7%, transgen 2.1%, sequenc 2.0%, popul 1.9%, delet 1.7%, insert 1.6%, allel 1.6%, sheep 1.3%, casein 1.3%] – *Genes and genomes, with emphasis on transgenic organisms, sequence analysis, and population studies.*
- (14) [allel 11.3%, patient 6.3%, gstm1 4.6%, gene 3.3%, mutat 2.6%, haplotyp 2.6%, apo 2.3%, hla 2.3%, dr3 1.9%, drb1 1.7%] – *Specific alleles (primarily in human patients), with emphasis on gene mutation, the glutathione S-transferase (GST) loci (GSTM1), and various haplotypes.*

**4.1.2.2. Agricultural, environmental, ecological studies**

- (14) [embryo 23.9%, somat 9.1%, somat.embryo 4.4%, medium 4.1%, callu 3.8%, regener 3.6%, calli 3.2%, embryogenesi 2.8%, cultur 2.5%, somat.embryogenesi 1.8%] – *Embryos and (somatic) embryogenisis, with emphasis on mediums, callus, and regeneration.*
- (29) [shoot 21.9%, mum 8.8%, medium 6.1%, explant 3.2%, cultur 2.6%, bud 2.5%, medium.supplement 2.5%, root 1.9%, regener 1.8%, supplement 1.6%] – *(Plant) shoots, with emphasis on explantation to various mediums for culture (micromoles, or muMs, are typical units of concentration).*
- (27) [root 15.6%, iaa 9.3%, shoot 2.7%, bulblet 1.9%, cut 1.7%, dry.weight 1.6%, plant 1.6%, dry 1.5%, iba 1.4%, growth 1.2%] – *Properties of roots, with primary emphasis on the growth stimulant indole acetic acid (IAA), and secondary emphasis on shoots and bulblets.*
- (37) [plant 9.4%, leav 3.9%, leaf 3.4%, content 2.9%, co2 2.5%, acid 1.9%, growth 1.8%, total 0.9%, seedl 0.8%, seed 0.8%] – *Plant structure and properties, with emphasis on leaves, content of various substances, and $CO_2$ interaction.*
- (33) [seed 30.2%, germin 16.3%, pollen 2.3%, seed.germin 2.1%, genotyp 1.5%, plant 1.3%, seedl 1.0%, matur 0.8%, toler 0.7%, cook 0.7%] – *Seeds/seedlings, particularly seed germination, with emphasis on pollen, genotypes, and plant maturation.*
- (52) [soil 55.0%, plant 3.2%, uptak 0.9%, nutrient 0.8%, gypsum 0.7%, organ 0.7%, wheat 0.6%, crop 0.6%, miner 0.5%, phosphogypsum 0.5%] – *Soil properties/composition, particularly in relation to plants and plant growth, with emphasis on water/nutrient uptake.*
- (24) [fertil 11.5%, crop 9.2%, soil 7.5%, manur 3.7%, urea 2.2%, dcd 1.8%, wheat 1.7%, applic 1.7%, npk

1.6%, n2o  1.5%] – *Fertilizers, particularly those containing manure and/or urea, with emphasis on crop behavior and soil properties.*

- (25)  [crop 18.4%, wheat 12.7%, yield  3.6%, intercrop  2.2%, maiz  1.6%, season  1.4%, sorghum  1.4%, cowpea  1.3%, groundnut  1.3%, sow  1.1%] – *Crops and intercropping systems, particularly those involving wheat and/or maize, with emphasis on yield and seasonal effects.*
- (24)  [irrig 21.6%, rice 11.5%, yield  6.2%, water  4.5%, schedul  2.5%, crop  1.7%, grain  1.6%, wheat  1.2%, grain.yield  1.0%, applic  1.0%] – *Irrigation, particularly the effects of various scheduling systems, with emphasis on yields of such crops as rice, grain, and wheat.*
- (56)  [yield 14.0%, plant  4.9%, grain  4.8%, seed  2.9%, season  2.0%, grain.yield  1.9%, field.experi  1.7%, experi.conduct  1.7%, field.experi.conduct  1.6%, maiz  1.4%] – *Yield conditions of various plants and grains, with emphasis on seed yield, seasonal effects, and field experimentation.*
- (28)  [weed 48.7%, herbicid  3.0%, yield  2.7%, hand.weed  2.1%, weed.control  1.9%, crop  1.6%, seed  1.4%, dry  1.2%, pendimethalin  1.2%, seed.yield  1.0%] – *Weeds, particularly weed control, with emphasis on herbicides and yield-determining attributes.*
- (13)  [resist 14.0%, sorghum 11.7%, midg  8.3%, rust  5.1%, glabrata  3.6%, downi  3.1%, mildew  3.1%, sorghum.midg  2.8%, downi.mildew  2.8%, millet  1.2%] – *Plant resistance properties, particularly to rust, sorghum midge, and downy mildew.*
- (18)  [mutant 31.3%, strain  3.3%, plasmodium  2.5%, wild.type  2.1%, nitrat  1.9%, wild  1.9%, mutant.strain  1.4%, enzym  1.2%, resist  1.1%, sap  1.1%] – *Mutant strains of organic compounds, as compared to wild type (typical form) strains, with emphasis on plasmodium and effects of nitrate.*
- (36)  [strain 42.9%, isol  9.1%, pfge  1.4%, resist  1.4%, serotyp  1.2%, type  1.1%, india  0.9%, mic  0.7%, gene  0.7%, pcr  0.7%] – *(Primarily isolated) strains, with emphasis on pulse-field gel electrophoresis (PFGE), resistance patterns, and serotyping.*
- (33)  [isol 18.7%, bacteria  6.2%, pseudomona  2.6%, solubil  2.5%, bacteri  2.3%, degrad  1.6%, mcp  1.4%, microbi  1.4%, pcp  1.3%, grub  1.2%] – *Isolates, particularly bacterial isolates, with emphasis on solubility, degradation, and the phylum Pseudomonas.*

- (95) [genet 10.9%, marker 9.4%, primer 8.0%, trait 5.0%, polymorph 3.4%, qtl 2.8%, amplifi 2.6%, rapd 1.9%, cultivar 1.6%, divers 1.4%] – *Genetic traits, with emphasis on markers (biological indicators), primers, and polymorphism.*
- (28) [chromosom 27.4%, speci 2.8%, male 2.7%, femal 2.4%, parasitoid 1.5%, biofilm 1.5%, sex 1.4%, queen 1.2%, indian 1.0%, mate 1.0%] – *Chromosomes in various species, with emphasis on male/female comparisons, parisitoids, and biofilms.*
- (57) [speci 50.2%, new.speci 5.0%, genu 2.4%, indian 1.7%, india 1.7%, new 1.2%, indian.speci 0.7%, record 0.5%, kei 0.4%, speci.genu 0.4%] – *Predominantly new species, from various genuses, with emphasis on species native to India.*
- (27) [milk 17.7%, breed 6.3%, lactat 6.2%, milk.yield 2.1%, egg 1.6%, cfu 1.4%, monocytogen 1.4%, hatch 1.3%, hatchl 1.3%, calv 1.1%] – *Lactation of various animal breeds, with emphasis on milk composition/yield, but with patterns of egg-laying and hatching discussed as well.*
- (33) [sugar 8.0%, ferment 3.5%, product 3.0%, juic 2.6%, pulp 2.2%, caroten 2.1%, cod 1.9%, cane 1.7%, fruit 1.7%, beta.caroten 1.2%] – *Sugar and its properties, with emphasis on fermentation, juice extraction, and production factors.*
- (24) [product 4.7%, india 3.0%, technolog 2.5%, bioga 2.2%, pollut 2.2%, ozon 2.1%, china 2.1%, food 2.0%, digest 1.7%, countri 1.4%] – *Production (in a broader sense) in India with emphasis on technology and environmental issues (such as biogas generation, pollution, and ozone usage).*
- (20) [fish 13.7%, mosquito 3.6%, dolphin 3.3%, organochlorin 3.3%, shrimp 2.4%, insecticid 2.2%, product 1.9%, seafood 1.9%, pesticid 1.8%, ddt 1.6%] – *Animal and insect studies, with emphasis on insecticides and pesticides (esp. organochlorines) and associated harmful effects on aquatic animals (esp. fish due to pesticide pollutant transport).*
- (40) [water 20.3%, land 3.2%, area 3.1%, pollut 2.1%, groundwat 1.7%, contamin 1.2%, sampl 1.1%, sewag 1.1%, drink 1.0%, resourc 0.9%] – *Water resources and its uses, as well as land usability, with emphasis on groundwater and pollution (and resultant contamination).*
- (24) [dose 5.4%, radon 4.9%, aerosol 3.1%, indoor 2.8%, winter 2.4%, dose.rate 2.4%, beach 2.2%, season 1.8%, spring 1.7%, region 1.7%] – *Dose-dependent activity,*

*particularly in radioactive emissions, with emphasis on dose rate, radon levels, and aerosols.*

- (28) [field 3.5%, wind 3.3%, echo 2.9%, solar 2.8%, radar 2.4%, plume 1.8%, surfac 1.6%, 226 1.2%, fring 1.2%, arecibo 1.1%] – *Physical fields (e.g. magnetic, gravitational), with emphasis on wind, echoes, and solar activity.*
- (36) [monsoon 24.3%, rainfal 7.2%, sea 3.2%, season 3.1%, summer.monsoon 2.7%, summer 2.1%, sea.level 1.9%, indian 1.8%, monsoon.season 1.7%, ocean 1.6%] – *Monsoons, with emphasis on rainfall, season, and sea level.*
- (23) [sediment 43.2%, benthic 1.9%, deposit 1.7%, river 1.5%, reservoir 1.4%, suspend.sediment 1.3%, zone 1.0%, carbon 0.8%, palynoassemblag 0.8%, core 0.8%] – *Sediments/sedimentation, particularly suspended sediment, with emphasis on benthic species and depositional conditions in rivers and reservoirs.*
- (28) [basin 14.4%, fault 6.1%, seismic 6.0%, tecton 3.1%, basement 2.7%, earthquak 2.6%, crust 2.2%, gondwana 1.8%, crustal 1.6%, sandston 1.4%] – *Basins, with emphasis on faults (rooted in seismic/tectonic activity) and basement characteristics.*
- (21) [basin 6.7%, assemblag 3.9%, late 2.5%, vertebra 2.0%, sandston 1.9%, format 1.5%, earli 1.5%, miocen 1.3%, sedimentari 1.3%, sediment 1.2%] – *Basins, with emphasis on assemblage, various vertebrae, and sandstone dating to prehistoric periods (esp. the Miocene age).*
- (18) [rock 19.8%, apron 5.4%, groundwat 3.9%, granit 2.2%, basalt 1.9%, volcan 1.8%, limeston 1.7%, apron.slippag 1.4%, aquif 1.4%, slippag 1.3%] – *Rocks, with emphasis on apron-to-apron slippage and groundwater activity.*
- (31) [forest 23.8%, habitat 4.4%, conserv 2.4%, biomass 2.2%, area 2.0%, eastern 1.3%, watersh 1.2%, peopl 1.2%, map 1.1%, district 1.1%] – *Forests, particularly as animal habitats, with emphasis on conservation, biomass (burning), watershed management, and area concerns.*

4.2. Medical case studies

4.2.1. Female/Child case studies

**4.2.1.1. Diseases affecting women and children in India**

- (24) [hiv 25.3%, medic 3.4%, test 2.8%, softwar 2.6%, drug 2.2%, benchmark 1.9%, assur 1.6%, knowledg 1.5%, inform 1.4%, hiv.infect 1.2%] – *Human immunodeficiency virus (HIV), with emphasis on medication/drugs, testing, and software tools.*

- (30) [health 17.1%, countri 12.3%, india 5.6%, public 3.8%, care 1.8%, health.care 1.7%, train 1.7%, linkag 1.1%, medicin 1.0%, cope 0.9%] – *General health concerns and public health care issues in India, particularly as they compare to other countries.*
- (27) [popul 12.5%, women 4.9%, loci 4.5%, famili 3.6%, cancer 2.5%, india 1.9%, cervic 1.8%, haplotyp 1.6%, allel 1.4%, str 1.2%] – *Population studies (primarily Indian), with emphasis on those pertaining to women (female matters), families, and cancer.*
- (31) [ag 6.3%, preval 4.1%, epilepsi 3.2%, women 2.7%, risk 2.4%, dementia 2.3%, bmi 2.0%, cancer 1.6%, popul 1.5%, morbid 1.3%] – *Age-based studies, with emphasis on women and prevalent risks/diseases (e.g. epilepsy, dementia, cancer).*
- (48) [children 32.3%, vitamin 3.2%, nutrit 2.0%, defici 1.9%, child 1.8%, ag 1.7%, cent 1.6%, zinc 1.5%, group 1.3%, vaccin 1.0%] – *Health issues pertaining to children, with emphasis on vitamin and nutrient deficiencies.*

#### 4.2.1.2. Uncommon diseases affecting children

- (24) [syndrom 5.2%, twin 2.9%, neuralgia 2.7%, bilater 2.7%, clinic 2.6%, infarct 2.5%, rare 2.4%, case 2.0%, cerebellar 1.9%, featur 1.6%] – *Properties and origins of various clinical syndromes, particularly those found more often in twins, such as neuralgia and bilateral disorders.*
- (25) [case 14.1%, congenit 4.8%, rare 4.1%, fistula 3.9%, anomali 2.5%, hydrocephalu 2.4%, secondari 1.9%, literatur 1.8%, report 1.2%, shunt 1.1%] – *Cases of rare congenital diseases/anomalies, with emphasis on fistulas and hydrocephalus.*
- (50) [year.old 14.1%, old 11.8%, year 7.9%, case 2.2%, right 2.2%, left 2.0%, rare 1.9%, abscess 1.4%, report 1.2%, old.male 1.2%] – *Studies in which subject's age is of importance, with emphasis on rare conditions and those involving abscesses.*
- (24) [cytolog 9.4%, aspir 8.3%, fine.needl.aspir 5.7%, fine.needl 5.7%, needl.aspir 5.6%, needl 5.4%, case 4.0%, fine 3.5%, diagnosi 2.7%, cell 2.1%] – *Cytology, with emphasis on aspiration (esp. fine-needle aspiration).*
- (18) [tumor 16.4%, case 6.8%, breast 3.4%, carcinoma 3.1%, p53 2.0%, alk 1.7%, tissu 1.5%, express 1.4%, cin 1.4%, et 1.4%] – *Clinical studies concerning tumors, with emphasis on tumors of the breast, carcinoma (invasive malignant tumor), and the ALK gene.*
- (22) [cyst 16.8%, imag 12.6%, case 2.9%, lesion 2.1%, abnorm 1.8%, hydatid 1.8%, neurenter 1.6%, demyelin

1.4%, fish 1.4%, hcc 1.3%] – *Clinical studies concerning cysts/cystic legions, with emphasis on imaging (abnormalities), hydatids, and neurenteric cysts.*

- (22) [imag 42.1%, color 6.8%, algorithm 1.6%, segment 1.2%, comput 1.1%, edg 1.1%, mrf 1.1%, camera 0.8%, featur 0.8%, scheme 0.8%] – *Imaging, esp. color imaging, with emphasis on algorithms, segmentation, and computation techniques.*

### 4.2.2. General patient studies

#### **4.2.2.1. Clinical studies**

- (25) [tuberculosi 8.4%, flap 5.0%, smear 3.9%, diagnosi 3.0%, stain 1.8%, skin 1.2%, treatment 1.1%, bone 1.1%, tubercular 1.1%, ear 1.1%] – *Tuberculosis, with emphasis on muscle/tissue flaps, smear methods, and diagnosis/treatment.*
- (24) [group 7.8%, neonat 5.7%, subgroup 5.5%, infant 5.4%, psa 3.5%, cow 2.7%, care 1.9%, tendon 1.8%, boolean 1.5%, babi 1.4%] – *Groups/subgroups of ailments affecting infants/neonates, with emphasis on prostate specific antigen (PSA) and care.*
- (32) [patient 11.5%, placebo 4.8%, drug 2.1%, score 1.9%, fev1 1.8%, knee 1.8%, pharmaci 1.6%, colchicin 1.3%, respons 1.3%, hospit 1.3%] – *Placebo-controlled clinical studies, particularly those involving drugs, with emphasis on scores (statistical measurements) and the FEV1 (forced expiratory volume 1) technique.*
- (35) [group 31.0%, patient 14.7%, patient.group 3.0%, group.group 2.9%, group.patient 1.7%, stone 0.8%, block 0.8%, 001 0.7%, month 0.7%, women 0.7%] – *Studies based on various (sorted) patient groups, with (separate) emphases on kidney stones and women.*
- (35) [ey 30.6%, iol 4.8%, patient 3.9%, retin 2.9%, visual 2.7%, month 1.4%, detach 1.4%, acuiti 1.3%, corneal 1.2%, posterior 1.2%] – *Eyes and eye conditions, with emphasis on intraocular lenses (IOLs), retinal characteristics (detachment), and acuity.*
- (56) [patient 31.4%, surgeri 3.2%, arteri 1.9%, left 1.6%, graft 1.5%, year 1.4%, laparoscop 1.3%, complic 1.2%, surgic 1.1%, recurr 1.1%] – *Clinical studies (mainly surgical) with emphasis on arterial activity, grafting, and laparoscopic surgery.*
- (36) [patient 26.9%, lesion 12.6%, clinic 1.7%, spinal 1.5%, neurolog 1.3%, case 1.1%, tuberculosi 1.1%, children 1.1%, heal 1.0%, surgic 0.8%] – *Clinical patient studies with emphasis on lesions, spinal irregularities, and neurological disorders.*

- (60) [patient 59.7%, year 0.7%, leprosi 0.7%, ag 0.6%, control 0.6%, diseas 0.6%, abnorm 0.6%, clinic 0.6%, diagnosi 0.5%, treatment 0.5%] – *General patient studies with slight emphasis on variance in age of patients and some emphasis on leprosy.*

#### 4.2.2.2. Infections and treatment

- (21) [pancreat 15.9%, patient 12.8%, acut 7.2%, renal 2.3%, patient.acut 2.0%, infect 1.9%, chronic.pancreat 1.6%, acut.pancreat 1.4%, fluid 1.1%, remiss 1.0%] – *Clinical studies with emphasis on pancreatic tissue and associated diseases (e.g. pancreatitis), of both acute and chronic natures, as well as renal failure.*
- (36) [patient 22.2%, infect 5.9%, hepat 5.5%, liver 4.7%, therapi 2.3%, transplant 2.0%, liver.diseas 1.6%, diseas 1.2%, regimen 1.2%, hbv 1.0%] – *Various infections observed in patients, with emphasis on hepatotoxicity (damaging effects on liver) and therapy (particularly transplantation).*
- (29) [antibodi 9.8%, patient 4.9%, igm 4.7%, antigen 3.9%, elisa 3.6%, igg 3.4%, tuberculosi 2.6%, detect 2.4%, test 2.2%, assai 2.1%] – *Antibodies, particularly immunoglobulin M (IgM) and G (IgG), in human patients, with emphasis on antigens, ELISA (enzyme-linked immnosorbent assay), and tuberculosis.*
- (23) [infect 20.9%, hev 4.1%, wssv 3.5%, outbreak 3.3%, preval 2.6%, viru 2.5%, diseas 2.3%, pcr 2.0%, hbv 1.3%, virus 1.2%] – *Various infections, with emphasis on Hepatitis E virus (HEV), white spot syndrome virus (WSSV), and outbreak conditions.*

## APPENDIX 5 – 2005 TAXONOMY

## FIGURE A5-1 – 2005 TAXONOMY – FOUR LEVEL

<table>
<tr><td rowspan="6">(5513) BIOMEDICAL; ENVIRON</td><td rowspan="3">(2626) BIOLOGICAL RESEARCH</td><td rowspan="2">(1458) ANIMAL EXPERIMENTS/ PLANT BIOLOGY</td><td>(807) PLANT BIOLOGY</td></tr>
<tr><td>(651) ANIMAL EXPERIMENTS</td></tr>
<tr><td colspan="2">(1168) CELL BIOLOGY/ GENETICS</td></tr>
<tr><td rowspan="3">(2887) CLINICAL MEDICINE; ENVIRON</td><td colspan="2">(1218) HUMAN PATIENT DISEASES</td></tr>
<tr><td rowspan="2">(1669) GEOLOGICAL/ MAT'L MECHANICS/ AGRICULTURAL RES</td><td>(952) SOIL/ CROP EXPERIMENTS</td></tr>
<tr><td>(717) GEOLOGICAL RES/ MATERIAL MECHANICS</td></tr>
<tr><td rowspan="7">(8795) PHYSICAL SCIENCES/ MATHEMATIC</td><td rowspan="3">(3691) MATHEMATIC</td><td colspan="2">(1372) ALGORITHMS/ NETWORK MODELING</td></tr>
<tr><td rowspan="2">(2319) MATH ANALYSIS</td><td>(1255) CONTINUUM ANALYSIS</td></tr>
<tr><td>(1064) MOLEC LEVEL CALC</td></tr>
<tr><td rowspan="4">(5104) PHYSICAL SCIENCES</td><td rowspan="2">(2867) SURF PHYS/ CHEM</td><td>(1576) FILM PHYS</td></tr>
<tr><td>(1291) FILM CHEM</td></tr>
<tr><td rowspan="2">(2237) COMPOUND CHEMISTRY</td><td>(939) CHEM BOND/ CRYS STRUCT</td></tr>
<tr><td>(1298) REACT/ CATAL/ SYNTH</td></tr>
</table>

## FIGURE A5-2 – 2005 TAXONOMY – FOUR LEVEL

(includes cluster numbers from computer output)

<table>
<tr><td rowspan="6">CAT 27 (5513) BIOMED; ENVIRON</td><td rowspan="3">CAT 22 (2626) BIOL RES</td><td rowspan="2">CAT 21 (1458) ANIM EXP/ PLANT BIOLOGY</td><td>CAT 10 (807) PLANT BIOLOGY</td></tr>
<tr><td>CAT 3 (651) ANIMAL EXPERIMENTS</td></tr>
<tr><td colspan="2">CAT 7 (1168) CELL BIOL/ GENETICS</td></tr>
<tr><td rowspan="3">CAT 26 (2887) CLIN MED; ENVIRON</td><td colspan="2">CAT 5 (1218) PATIENT DISEASES</td></tr>
<tr><td rowspan="2">CAT 17 (1669) (1669) GEOLOGICAL/ MAT'L MECHANICS/ AGRICULTURAL RES</td><td>CAT 15 (952) SOIL/ CROP EXP</td></tr>
<tr><td>CAT 12 (717) GEOLOGICAL RES/ MAT'L MECHANICS</td></tr>
<tr><td rowspan="7">CAT 29 (8795) PHYS SCI/ MATH</td><td rowspan="3">CAT 23 (3691) MATH</td><td colspan="2">CAT 14 (1372) ALG/ NETWORK MODEL</td></tr>
<tr><td rowspan="2">CAT 18 (2319) MATH ANALYSIS</td><td>CAT 11 (1255) FLOW/ FIELD DIFF EQ</td></tr>
<tr><td>CAT 13 (1064) MOLEC LEVEL CALC</td></tr>
<tr><td rowspan="4">CAT 28 (5104) PHYS SCI</td><td rowspan="2">CAT 24 (2867) SURF PHYS/ CHEM</td><td>CAT 20 (1576) FILM PHYS</td></tr>
<tr><td>CAT 16 (1291) FILM CHEM</td></tr>
<tr><td rowspan="2">CAT 25 (2237) CHEM REACT</td><td>CAT 19 (939) CHEM BOND/ CRYS STRUCT</td></tr>
<tr><td>CAT 9 (1298) REACT/ CATAL/ SYNTH</td></tr>
</table>

For each of the nodes in the first three levels of Figures A5-1 and A5-2, there are two types of data generated by the computer output:

Syntax (Important phrases, phrase groupings)
Metrics (Prolific Authors, journals, institutions, etc)

Each node in the fourth level (the leaf nodes) also contains the titles of all the records in the node. This Appendix presents the Syntax and Metrics for all four levels. Because of the sheer volume of material contained in the >14000 record titles, the record titles from each leaf cluster will not be presented. However, having all the record titles available for each elemental cluster, in addition to the Syntax and Metrics, provides a very powerful capability for analyzing the clusters and gaining in-depth insight to their contents.

## A5-1. Syntax and Metrics for each Taxonomy Node

HIERARCHICAL TAXONOMY NODE DETAILS

**LEVEL 0**
This category/ cluster is not shown on Figure A4-2. It is the node that contains all the retrieved records)

CLUSTER 30 - ROOT
(14308 Records)

Cluster Syntax Features

Descriptive Terms
temperatur 1.2%, model 1.1%, activ 1.0%, acid 0.9%, complex 0.9%, system 0.8%, structur 0.8%, patient 0.8%, reaction 0.7%, two 0.7%, compound 0.7%, phase 0.7%, concentr 0.7%, cell 0.6%, data 0.6%, level 0.6%, high 0.6%, paramet 0.5%, ion 0.5%, (14.84%)

Single Word Terms
two 2958, temperatur 2319, high 2284, structur 2182, on 2177, activ 2175, system 2118, data 2084, model 2007, time 1932, paramet 1909, concentr 1820, acid 1792, level 1743, condit 1706, form 1699, function 1606, properti 1581, rate 1553, three 1523

Double Word Terms
rai.diffract 452, room.temperatur 393, electron.microscopi 302, hydrogen.bond 271, scan.electron 258, plai.role 250, first.time 230, amino.acid 227, first.order 226, thin.film 222, crystal.structur 212, activ.energi 208, solid.state 193, aqueou.solut 193, experiment.data 186, bodi.weight 185, singl.crystal 183, experi.conduct 181, particl.size 178, molecular.weight 175

Triple Word Terms
scan.electron.microscopi 167, rai.diffract.xrd 119, transmiss.electron.microscopi 118, fourier.transform.infrar 107, differenti.scan.calorimetri 101, polymeras.chain.reaction 93, electron.microscopi.sem 69, superoxid.dismutas.sod 63, glass.transit.temperatur 63, scan.electron.microscop 61, singl.crystal.rai 61, powder.rai.diffract 59, field.experi.conduct 58, artifici.neural.network 57, densiti.function.theori 57, verlag.gmbh.kgaa 53, chain.reaction.pcr 52, intermolecular.hydrogen.bond 51, atom.forc.microscopi 51, vch.verlag.gmbh 50

Cluster Metrics

Authors
kumar, a 206; kumar, s 197; kumar, r 142; singh, s 112; banerjee, s 100; singh, r 97; sharma, a 84; ghosh, s 82; sharma, s 78; das, s 78; gupta, s 68; gupta, a 68; singh, ak 65; abe, k 64; singh, b 62; kumar, v 61; singh, n 60; sharma, r 60; srivastava, a 57; li, j 55

Sources
asian journal of chemistry 289; current science 182; journal of the indian chemical society 159; tetrahedron letters 157; journal of food science and technology-mysore 144;

indian journal of chemistry section b-organic chemistry including medicinal chemistry 138; acta crystallographica section e-structure reports online 127; journal of applied physics 105; physical review b 103; pramana-journal of physics 90; spectrochimica acta part a-molecular and biomolecular spectroscopy 87; indian veterinary journal 86; indian journal of physics and proceedings of the indian association for the cultivation of science 84; journal of the geological society of india 83; indian journal of animal sciences 83; journal of applied polymer science 78; indian journal of pure & applied physics 78; physical review d 73; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 72; bulletin of materials science 72

Keywords
chemistry, multidisciplinary 914; chemistry, organic 680; chemistry, physical 633; materials science, multidisciplinary 603; biochemistry & molecular biology 506; physics, multidisciplinary 498; engineering, electrical & electronic 336; physics, condensed matter 324; polymer science 316; chemistry, inorganic & nuclear 283; physics, applied 270; india 269; chemistry, analytical 267; crystallography 262; engineering, chemical 259; physics, atomic, molecular & chemical 256; model 255; multidisciplinary sciences 252; chemistry, medicinal 252; growth 246

Publication Year
2005 13708; 2006 393; 2004 204; 2002 2; 2003 1

Country
india 14308; usa 999; germany 450; japan 340; england 302; france 267; peoples r china 254; south korea 204; italy 141; canada 141; australia 141; russia 138; taiwan 123; switzerland 111; spain 99; netherlands 99; poland 85; brazil 85; sweden 76; czech republic 56

Institution
indian inst technol 1730; indian inst sci 654; bhabha atom res ctr 358; univ delhi 298; tata inst fundamental res 293; indian inst chem technol 255; all india inst med sci 246; jadavpur univ 224; natl chem lab 220; banaras hindu univ 200; univ madras 199; indian assoc cultivat sci 182; panjab univ 169; anna univ 167; aligarh muslim univ 152; indian stat inst 145; univ hyderabad 143; univ calcutta 134; csir 132; natl inst technol 131

DataBase
science citation index 14308

Citations
lowry oh, 1951, j biol chem, v193, p265 297; laemmli uk, 1970, nature, v227, p680 153; sambrook j, 1989, mol cloning lab manu 112; spek al, 2003, j appl crystallogr 1, v36, p7 104; murashige t, 1962, physiol plantarum, v15, p473 89; bradford mm, 1976, anal biochem, v72, p248 87; farrugia lj, 1997, j appl crystallogr, v30, p565 85; sheldrick gm, 1997, shelxs97 shelxl97 81; ohkawa h, 1979, anal biochem, v95, p351 58; rotruck jt, 1973, science, v179, p588 55; habig wh, 1974, j biol chem, v249, p7130 55; geary wj, 1971, coordin chem rev, v7, p81 55; altschul sf, 1997, nucleic acids res, v25, p3389 55;

eidelman s, 2004, phys lett b, v592, p1 54; nardelli m, 1995, j appl crystallogr, v28, p659 52; otwinowski z, 1997, method enzymol, v276, p307 49; adler ss, 2003, phys rev lett, v91 44; sheldrick gm, 1990, acta crystallogr a, v46, p467 42; lee c, 1988, phys rev b, v37, p785 42; lowry oh, 1951, j biol chem, v193, p275 41

**LEVEL 1**

CLUSTER 27
- **BIOMEDICAL; ENVIRONMENTAL**

(5513 Records)

Cluster Syntax Features

Descriptive Terms
patient 4.0%, cell 2.0%, activ 1.7%, protein 1.7%, level 1.5%, plant 1.1%, gene 1.1%, treatment 1.0%, isol 0.9%, speci 0.8%, control 0.8%, extract 0.7%, soil 0.7%, enzym 0.7%, infect 0.7%, acid 0.6%, rat 0.6%, induc 0.6%, strain 0.6%, (22.60%)

Single Word Terms
level 1234, activ 1208, two 1147, high 1016, control 975, on 963, treatment 891, patient 852, cell 803, protein 773, total 763, acid 756, three 744, concentr 733, reduc 719, induc 718, time 712, product 706, data 695, system 654

Double Word Terms
bodi.weight 185, lipid.peroxid 167, amino.acid 147, plai.role 141, experi.conduct 133, superoxid.dismutas 119, escherichia.coli 116, oxid.stress 115, first.time 104, sampl.collect 98, chain.reaction 95, polymeras.chain 93, dose.depend 89, glutathion.peroxidas 84, field.experi 81, cell.line 80, antioxid.enzym 76, free.radic 76, mycobacterium.tuberculosi 75, depend.manner 72

Triple Word Terms
polymeras.chain.reaction 93, superoxid.dismutas.sod 60, field.experi.conduct 57, chain.reaction.pcr 52, reactiv.oxygen.speci 49, thiobarbitur.acid.reactiv 47, acid.reactiv.substanc 46, dose.depend.manner 43, rice.oryza.sativa 39, wheat.triticum.aestivum 37, glutathion.transferas.gst 36, dismutas.sod.catalas 36, level.lipid.peroxid 35, reduc.glutathion.gsh 34, reactiv.substanc.tbar 33, link.immunosorb.assai 32, glutathion.peroxidas.gpx 32, enzym.link.immunosorb 32, oxygen.speci.ro 31, central.nervou.system 31

Cluster Metrics

Authors
kumar, s 76; kumar, a 76; singh, r 64; singh, s 62; kumar, r 57; sharma, a 51; sharma, s 43; gupta, s 41; srivastava, a 37; gupta, ak 35; das, s 34; gupta, sk 33; singh, m 29; singh, n 28; gupta, a 28; kumar, v 27; bhattacharya, sk 27; sinha, s 26; singh, a 26; kumar, n 26

Sources
current science 160; journal of food science and technology-mysore 130; indian veterinary journal 86; indian journal of animal sciences 81; journal of the geological society of india 71; molecular and cellular biochemistry 64; asian journal of chemistry 63; indian journal of medical research 45; journal of environmental biology 44;

biochemical and biophysical research communications 44; indian journal of agronomy 43; indian journal of agricultural sciences 40; world journal of microbiology & biotechnology 38; transactions of the indian institute of metals 35; bioorganic & medicinal chemistry letters 35; geophysical research letters 25; environmental monitoring and assessment 25; journal of ethnopharmacology 23; in vitro cellular & developmental biology-plant 23; phytotherapy research 22

Keywords
biochemistry & molecular biology 402; india 251; multidisciplinary sciences 189; environmental sciences 189; food science & technology 185; chemistry, medicinal 173; biotechnology & applied microbiology 172; plant sciences 171; pharmacology & pharmacy 170; plant sciences 161; geosciences, multidisciplinary 161; surgery 154; agronomy 147; growth 147; agriculture, dairy & animal science 146; immunology 141; expression 137; pharmacology & pharmacy 134; cell biology 134; biophysics 129

Publication Year
2005 5272; 2006 128; 2004 110; 2002 2; 2003 1

Country
india 5513; usa 383; england 139; germany 116; japan 92; france 57; australia 56; canada 52; peoples r china 51; south korea 42; italy 38; switzerland 26; sweden 23; netherlands 23; spain 22; thailand 19; brazil 19; hungary 18; singapore 16; belgium 16

Institution
indian inst technol 242; all india inst med sci 230; indian inst sci 124; postgrad inst med educ & res 117; univ delhi 113; univ madras 93; bhabha atom res ctr 84; indian agr res inst 81; sanjay gandhi postgrad inst med sci 79; jawaharlal nehru univ 77; christian med coll & hosp 77; indian vet res inst 76; cent drug res inst 71; punjab agr univ 69; banaras hindu univ 66; natl inst oceanog 60; cent food technol res inst 60; aligarh muslim univ 58; annamalai univ 56; natl geophys res inst 49

DataBase
science citation index 5513

Citations
lowry oh, 1951, j biol chem, v193, p265 289; laemmli uk, 1970, nature, v227, p680 146; sambrook j, 1989, mol cloning lab manu 111; murashige t, 1962, physiol plantarum, v15, p473 89; bradford mm, 1976, anal biochem, v72, p248 80; ohkawa h, 1979, anal biochem, v95, p351 57; habig wh, 1974, j biol chem, v249, p7130 55; rotruck jt, 1973, science, v179, p588 53; altschul sf, 1997, nucleic acids res, v25, p3389 48; ellman gl, 1959, arch biochem biophys, v82, p70 41; towbin h, 1979, p natl acad sci usa, v76, p4350 40; lowry oh, 1951, j biol chem, v193, p275 40; marklund s, 1974, eur j biochem, v47, p469 38; sinha ak, 1972, anal biochem, v47, p389 36; thompson jd, 1994, nucleic acids res, v22, p4673 34; moron ms, 1979, biochim biophys acta, v582, p67 34; miller gl, 1959, anal chem, v31, p426 33; kakkar p, 1984, indian j biochem bio, v21, p130 30; folch j, 1957, j biol chem, v226, p497 28; *aoac, 1990, off meth an 27

CLUSTER 29
- **PHYSICAL SCIENCES; MATHEMATICS**

(8795 Records)

Cluster Syntax Features

Descriptive Terms
temperatur 1.8%, model 1.4%, complex 1.4%, reaction 1.2%, structur 1.1%, phase 1.1%, ion 1.0%, film 1.0%, system 1.0%, solut 0.9%, energi 0.8%, state 0.7%, compound 0.7%, acid 0.7%, electron 0.7%, paramet 0.7%, crystal 0.7%, two 0.6%, properti 0.6%, (18.70%)

Single Word Terms
temperatur 1962, two 1811, structur 1743, model 1479, system 1464, paramet 1420, data 1389, solut 1271, high 1268, form 1247, properti 1239, time 1220, on 1214, electron 1193, reaction 1190, energi 1176, phase 1150, paper 1148, order 1135, function 1120

Double Word Terms
rai.diffract 448, room.temperatur 374, electron.microscopi 264, hydrogen.bond 263, scan.electron 234, thin.film 220, first.order 217, activ.energi 202, crystal.structur 197, aqueou.solut 187, singl.crystal 181, solid.state 174, experiment.data 166, magnet.field 161, particl.size 160, two.dimension 157, titl.compound 154, transit.temperatur 145, low.temperatur 142, metal.ion 141

Triple Word Terms
scan.electron.microscopi 153, rai.diffract.xrd 118, transmiss.electron.microscopi 104, fourier.transform.infrar 100, differenti.scan.calorimetri 96, electron.microscopi.sem 64, glass.transit.temperatur 62, singl.crystal.rai 60, powder.rai.diffract 59, densiti.function.theori 57, scan.electron.microscop 54, verlag.gmbh.kgaa 53, intermolecular.hydrogen.bond 51, vch.verlag.gmbh 50, artifici.neural.network 49, atom.forc.microscopi 47, center.dot.hydrogen 46, transform.infrar.spectroscopi 45, optic.band.gap 43, solid.state.reaction 42

Cluster Metrics

Authors
kumar, a 130; kumar, s 121; kumar, r 85; banerjee, s 85; abe, k 64; ghosh, s 58; li, j 54; zhang, zp 50; singh, s 50; singh, ak 47; ravikumar, k 46; das, s 44; chen, a 42; singh, b 41; kim, hj 41; kang, jh 41; gupta, a 40; villa, s 39; sengupta, s 39; matsumoto, t 39

Sources
asian journal of chemistry 226; tetrahedron letters 153; journal of the indian chemical society 142; acta crystallographica section e-structure reports online 127; indian journal of chemistry section b-organic chemistry including medicinal chemistry 119; journal of

applied physics 104; physical review b 103; pramana-journal of physics 88; spectrochimica acta part a-molecular and biomolecular spectroscopy 87; indian journal of physics and proceedings of the indian association for the cultivation of science 79; indian journal of pure & applied physics 77; physical review d 73; journal of applied polymer science 73; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 71; physica b-condensed matter 70; bulletin of materials science 69; physical review letters 68; journal of physical chemistry b 65; physical review e 57; journal of chemical physics 56

Keywords
chemistry, multidisciplinary 797; chemistry, organic 642; chemistry, physical 621; materials science, multidisciplinary 538; physics, multidisciplinary 488; physics, condensed matter 324; engineering, electrical & electronic 322; polymer science 309; chemistry, inorganic & nuclear 279; physics, applied 264; crystallography 261; physics, atomic, molecular & chemical 254; chemistry, analytical 236; derivatives 212; materials science, multidisciplinary 211; behavior 201; engineering, chemical 198; model 195; systems 193; physics, condensed matter 186

Publication Year
2005 8436; 2006 265; 2004 94

Country
india 8795; usa 616; germany 334; japan 248; france 210; peoples r china 203; england 163; south korea 162; russia 131; taiwan 112; italy 103; canada 89; switzerland 85; australia 85; poland 78; spain 77; netherlands 76; brazil 66; sweden 53; czech republic 48

Institution
indian inst technol 1488; indian inst sci 530; bhabha atom res ctr 274; tata inst fundamental res 263; indian inst chem technol 228; natl chem lab 203; univ delhi 185; jadavpur univ 183; indian assoc cultivat sci 171; anna univ 137; banaras hindu univ 134; panjab univ 127; natl inst technol 114; indian stat inst 114; univ hyderabad 113; univ madras 106; saha inst nucl phys 102; chinese acad sci 95; aligarh muslim univ 94; univ calcutta 90

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Citations
spek al, 2003, j appl crystallogr 1, v36, p7 104; farrugia lj, 1997, j appl crystallogr, v30, p565 85; sheldrick gm, 1997, shelxs97 shelxl97 81; geary wj, 1971, coordin chem rev, v7, p81 55; eidelman s, 2004, phys lett b, v592, p1 54; nardelli m, 1995, j appl crystallogr, v28, p659 52; adler ss, 2003, phys rev lett, v91 44; otwinowski z, 1997, method enzymol, v276, p307 43; sheldrick gm, 1990, acta crystallogr a, v46, p467 42; lee c, 1988, phys rev b, v37, p785 41; north act, 1968, acta crystallogr a, v24, p351 37; cremer d, 1975, j am chem soc, v97, p1354 37; becke ad, 1993, j chem phys, v98, p5648 36; sheldrick gm, 1997, shelxl97 35; bernstein j, 1995, angew chem int edit, v34, p1555

35; welton t, 1999, chem rev, v99, p2071 34; lever abp, 1984, inorganic elect spec 33; kurokawa s, 2003, nucl instrum meth a, v499, p1 33; abashian a, 2002, nucl instrum meth a, v479, p117 33; frisch mj, 1998, gaussian 98 revision 30

**LEVEL 2**

CLUSTER 22

- **BIOLOGICAL RESEARCH**

(2626 Records)

Cluster Syntax Features

Descriptive Terms
cell 4.6%, protein 4.3%, activ 3.8%, plant 1.8%, extract 1.8%, enzym 1.8%, level 1.7%, rat 1.7%, acid 1.5%, induc 1.4%, gene 1.3%, express 1.2%, inhibit 1.1%, isol 1.0%, treatment 1.0%, seed 0.9%, dna 0.8%, dose 0.7%, antioxid 0.7%, (34.08%)

Single Word Terms
activ 1001, level 752, protein 704, cell 669, acid 667, induc 632, control 530, treatment 525, concentr 509, reduc 498, two 444, enzym 439, product 437, inhibit 425, plant 417, high 403, extract 400, role 385, content 385, isol 384

Double Word Terms
bodi.weight 167, lipid.peroxid 162, amino.acid 141, superoxid.dismutas 116, oxid.stress 108, escherichia.coli 108, plai.role 95, dose.depend 87, glutathion.peroxidas 83, cell.line 77, antioxid.enzym 76, free.radic 71, depend.manner 70, reduc.glutathion 68, fatti.acid 68, first.time 65, molecular.weight 65, sd.page 62, glutathion.gsh 62, gene.express 59

Triple Word Terms
superoxid.dismutas.sod 59, reactiv.oxygen.speci 49, thiobarbitur.acid.reactiv 44, acid.reactiv.substanc 43, dose.depend.manner 41, dismutas.sod.catalas 36, glutathion.transferas.gst 34, reduc.glutathion.gsh 33, level.lipid.peroxid 33, glutathion.peroxidas.gpx 32, superoxid.dismutas.catalas 31, reactiv.substanc.tbar 31, oxygen.speci.ro 31, polymeras.chain.reaction 31, induc.oxid.stress 30, lipid.peroxid.lpo 28, murashig.skoog.medium 28, male.wistar.rat 27, sod.catalas.cat 27, 100.bodi.weight 26

Cluster Metrics

Authors
kumar, s 33; singh, s 31; singh, r 29; kumar, a 29; sharma, s 27; kumar, r 24; gupta, sk 24; sharma, a 22; gupta, s 22; das, s 20; sinha, s 18; srivastava, ak 17; singh, a 17; singh, j 15; sharma, rk 15; pandey, a 14; kumar, v 14; kumar, m 14; varalakshmi, p 13; subramanian, s 13

Sources
journal of food science and technology-mysore 125; molecular and cellular biochemistry 60; indian journal of animal sciences 51; asian journal of chemistry 50; current science 44; biochemical and biophysical research communications 44; bioorganic & medicinal

chemistry letters 35; world journal of microbiology & biotechnology 33; journal of environmental biology 30; indian veterinary journal 29; in vitro cellular & developmental biology-plant 23; phytotherapy research 22; nucleic acids research 19; journal of biological chemistry 19; indian journal of chemistry section b-organic chemistry including medicinal chemistry 19; indian journal of biochemistry & biophysics 19; journal of ethnopharmacology 18; journal of essential oil research 18; bioorganic & medicinal chemistry 17; food chemistry 16

Keywords
biochemistry & molecular biology 368; food science & technology 174; chemistry, medicinal 166; biotechnology & applied microbiology 154; pharmacology & pharmacy 149; plant sciences 129; biophysics 126; plant sciences 125; pharmacology & pharmacy 124; expression 111; cell biology 110; growth 109; environmental sciences 103; oxidative stress 99; cells 97; chemistry, multidisciplinary 96; agriculture, dairy & animal science 93; protein 86; toxicology 85; proteins 74

Publication Year
2005 2498; 2006 79; 2004 47; 2003 1; 2002 1

Country
india 2626; usa 145; germany 54; japan 44; england 31; south korea 25; france 19; peoples r china 15; hungary 15; canada 12; italy 11; australia 9; switzerland 6; sweden 6; taiwan 5; spain 5; philippines 5; bangladesh 5; netherlands 4; kuwait 4

Institution
univ madras 78; indian inst technol 70; univ delhi 67; indian inst sci 65; cent drug res inst 63; cent food technol res inst 57; jawaharlal nehru univ 52; indian vet res inst 52; bhabha atom res ctr 51; punjab agr univ 48; indian agr res inst 47; annamalai univ 47; all india inst med sci 42; aligarh muslim univ 42; ctr cellular & mol biol 39; banaras hindu univ 37; indian inst chem biol 36; panjab univ 35; bose inst 32; csir 31

DataBase
science citation index 2626

Citations
lowry oh, 1951, j biol chem, v193, p265 284; laemmli uk, 1970, nature, v227, p680 143; murashige t, 1962, physiol plantarum, v15, p473 87; sambrook j, 1989, mol cloning lab manu 86; bradford mm, 1976, anal biochem, v72, p248 80; ohkawa h, 1979, anal biochem, v95, p351 56; habig wh, 1974, j biol chem, v249, p7130 55; rotruck jt, 1973, science, v179, p588 53; altschul sf, 1997, nucleic acids res, v25, p3389 44; ellman gl, 1959, arch biochem biophys, v82, p70 41; towbin h, 1979, p natl acad sci usa, v76, p4350 38; lowry oh, 1951, j biol chem, v193, p275 37; marklund s, 1974, eur j biochem, v47, p469 36; sinha ak, 1972, anal biochem, v47, p389 35; moron ms, 1979, biochim biophys acta, v582, p67 34; miller gl, 1959, anal chem, v31, p426 33; thompson jd, 1994, nucleic acids res, v22, p4673 30; kakkar p, 1984, indian j biochem bio, v21, p130 30; folch j, 1957, j biol chem, v226, p497 27; *aoac, 1990, off meth an 27

CLUSTER 26

- **CLINICAL MEDICINE; ENVIRONMENT**

(2887 Records)

Cluster Syntax Features

Descriptive Terms
patient 11.3%, speci 1.2%, indian 1.2%, diseas 1.1%, soil 1.0%, ag 1.0%, popul 1.0%, infect 0.9%, area 0.8%, region 0.7%, clinic 0.7%, test 0.7%, water 0.6%, level 0.6%, control 0.6%, treatment 0.6%, mean 0.6%, women 0.5%, high 0.5%, (26.02%)

Single Word Terms
patient 771, two 703, on 619, high 613, data 507, level 482, control 445, three 442, indian 440, total 437, ag 437, rate 430, region 429, area 426, time 401, mean 385, diseas 382, low 372, treatment 366, posit 358

Double Word Terms
experi.conduct 84, sampl.collect 63, chain.reaction 63, field.experi 63, polymeras.chain 62, mean.ag 59, male.femal 57, patient.patient 56, risk.factor 54, two.patient 50, on.patient 48, plai.role 46, posit.correl 46, winter.season 44, confid.interv 44, west.bengal 44, arabian.sea 44, odd.ratio 44, indian.popul 43, on.hundr 43

Triple Word Terms
polymeras.chain.reaction 62, field.experi.conduct 45, chain.reaction.pcr 32, magnet.reson.imag 28, fragment.length.polymorph 27, rice.oryza.sativa 26, wheat.triticum.aestivum 26, bodi.mass.index 22, amplifi.polymorph.dna 22, restrict.fragment.length 20, human.immunodefici.viru 20, ratio.confid.interv 20, sea.surfac.temperatur 19, odd.ratio.confid 19, polymorph.dna.rapd 17, ag.sex.match 17, world.health.organ 17, emend.fiori.paol 16, triticum.aestivum.emend 16, fine.needl.aspir 16

Cluster Metrics

Authors
kumar, a 47; kumar, s 43; singh, r 35; kumar, r 33; singh, s 31; srivastava, a 30; sharma, a 29; gupta, ak 27; bhattacharya, sk 25; gupta, v 20; gupta, s 19; kumar, n 18; singh, m 16; sharma, s 16; sharma, n 16; gupta, a 16; singh, n 15; mannan, sl 15; gupta, rk 15; singh, vp 14

Sources
current science 116; journal of the geological society of india 71; indian veterinary journal 57; indian journal of medical research 39; indian journal of agronomy 39; transactions of the indian institute of metals 34; indian journal of animal sciences 30; indian journal of agricultural sciences 28; geophysical research letters 25; journal of earth

system science 22; environmental monitoring and assessment 22; national medical journal of india 18; environmental geology 18; atmospheric environment 18; neurology india 15; international journal of remote sensing 15; journal of environmental biology 14; euphytica 14; journal of clinical microbiology 13; asian journal of chemistry 13

Keywords
india 229; geosciences, multidisciplinary 160; surgery 150; multidisciplinary sciences 127; agronomy 113; public, environmental & occupational health 98; occupational health 98; public, environmental & 98; environmental sciences 86; clinical neurology 84; ophthalmology 79; veterinary sciences 77; medicine, general & internal 77; environmental sciences 73; immunology 71; materials science, multidisciplinary 65; children 62; prevalence 59; diagnosis 56; tropical medicine 55

Publication Year
2005 2774; 2004 63; 2006 49; 2002 1

Country
india 2887; usa 238; england 108; germany 62; japan 48; australia 47; canada 40; france 38; peoples r china 36; italy 27; switzerland 20; netherlands 19; sweden 17; spain 17; south korea 17; thailand 16; brazil 15; singapore 13; mexico 13; belgium 13

Institution
all india inst med sci 188; indian inst technol 172; postgrad inst med educ & res 88; sanjay gandhi postgrad inst med sci 71; christian med coll & hosp 66; indian inst sci 59; natl inst oceanog 51; natl geophys res inst 49; univ delhi 46; indian agr res inst 34; indira gandhi ctr atom res 33; bhabha atom res ctr 33; tata mem hosp 32; sree chitra tirunal inst med sci & technol 29; indian council med res 29; banaras hindu univ 29; indian stat inst 28; jawaharlal nehru univ 25; phys res lab 24; natl inst mental hlth & neurosci 24

DataBase
science citation index 2887

Citations
sambrook j, 1989, mol cloning lab manu 25; miller sa, 1988, nucleic acids res, v16, p1215 22; williams jgk, 1990, nucleic acids res, v18, p6531 16; kalnay e, 1996, b am meteorol soc, v77, p437 16; jackson ml, 1973, soil chem anal 15; sneath pha, 1973, numerical taxonomy 13; walkley a, 1934, soil sci, v37, p29 12; wild s, 2004, diabetes care, v27, p1047 11; shankar d, 2002, prog oceanogr, v52, p63 11; matthews dr, 1985, diabetologia, v28, p412 11; vos p, 1995, nucleic acids res, v23, p4407 10; thamban m, 2001, palaeogeogr palaeocl, v165, p113 10; nei m, 1973, p national academy s, v70, p3321 10; subbiah bv, 1956, curr sci, v25, p259 9; ramachandran a, 2001, diabetologia, v44, p1094 9; gomez ka, 1984, stat procedures agr 9; friedewald wt, 1972, clin chem, v18, p499 9; sirocko f, 1993, nature, v364, p322 8; myers n, 2000, nature, v403, p853 8; mccreary jp, 1993, prog oceanogr, v31, p181 8

CLUSTER 23

- **MATHEMATICS**

(3691 Records)

Cluster Syntax Features

Descriptive Terms
model 4.3%, system 1.8%, algorithm 1.4%, equat 1.3%, paper 1.3%, energi 1.2%, field 1.2%, flow 1.0%, function 1.0%, state 1.0%, paramet 1.0%, wave 0.9%, data 0.8%, simul 0.8%, time 0.8%, two 0.8%, network 0.7%, theori 0.7%, gener 0.7%, (23.44%)

Single Word Terms
model 1134, two 962, paper 953, system 866, paramet 738, data 719, time 694, function 653, gener 616, on 615, energi 597, experiment 596, equat 545, order 544, state 537, field 525, number 513, high 497, structur 494, simul 493

Double Word Terms
experiment.data 119, two.dimension 117, magnet.field 111, neural.network 105, cross.section 103, finit.element 101, steadi.state 75, boundari.condit 75, three.dimension 75, differenti.equat 72, genet.algorithm 68, non.linear 65, first.order 60, power.law 59, densiti.function 59, on.dimension 58, heat.transfer 57, ground.state 56, close.form 53, mathemat.model 52

Triple Word Terms
artifici.neural.network 48, densiti.function.theori 34, mont.carlo.simul 30, neural.network.ann 28, neural.network.model 27, bell.detector.kekb 27, differenti.cross.section 19, vertic.bar.vertic 18, partial.differenti.equat 18, close.form.solut 17, bar.vertic.bar 17, order.shear.deform 17, ordinari.differenti.equat 17, finit.element.model 17, shear.deform.theori 17, root.200.gev 16, signal.nois.ratio 16, navier.stoke.equat 16, mass.transfer.coeffici 16, model.experiment.data 15

Cluster Metrics

Authors
kumar, a 68; kumar, s 65; banerjee, s 64; abe, k 64; li, j 52; zhang, zp 50; chen, a 42; kang, jh 41; villa, s 39; matsumoto, t 39; kumar, r 39; kim, hj 39; zhang, lm 34; yamauchi, m 34; yamashita, y 34; wang, ch 34; uno, s 34; uehara, s 34; tian, xc 34; teramoto, y 34

Sources
physical review d 73; physical review letters 64; physical review b 62; physics letters b 55; physical review e 51; indian journal of pure & applied physics 44; pramana-journal of physics 38; journal of chemical physics 38; physics of plasmas 34; physical review a 31; iete journal of research 31; astrophysical journal 31; astronomy & astrophysics 31; physical review c 30; journal of high energy physics 29; indian journal of physics and proceedings of the indian association for the cultivation of science 29; journal of applied

physics 28; physica b-condensed matter 27; journal of physics a-mathematical and general 26; journal of sound and vibration 25

Keywords
physics, multidisciplinary 338; engineering, electrical & electronic 274; mathematics, applied 168; mechanics 155; model 154; physics, atomic, molecular & chemical 153; physics, condensed matter 141; engineering, mechanical 140; astronomy & astrophysics 136; physics, fluids & plasmas 134; physics, particles & fields 133; systems 115; chemistry, physical 107; optics 107; physics, applied 103; engineering, chemical 103; physics, nuclear 100; mathematics 98; physics, mathematical 92; physics, particles & fields 88

Publication Year
2005 3531; 2006 122; 2004 38

Country
india 3691; usa 444; germany 203; peoples r china 162; france 144; japan 140; russia 125; south korea 107; england 101; taiwan 73; italy 71; canada 70; australia 69; switzerland 68; poland 66; netherlands 64; brazil 58; sweden 47; spain 39; czech republic 39

Institution
indian inst technol 863; indian inst sci 270; tata inst fundamental res 188; indian stat inst 111; bhabha atom res ctr 97; panjab univ 93; univ delhi 91; inst high energy phys 85; jadavpur univ 83; saha inst nucl phys 70; korea univ 68; princeton univ 65; univ sci & technol china 64; banaras hindu univ 63; chinese acad sci 62; univ tokyo 58; natl inst technol 58; inst theoret & expt phys 57; univ tsukuba 52; tokyo inst technol 51

DataBase
science citation index 3691

Citations
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CLUSTER 28

- **PHYSICAL SCIENCES**

(5104 Records)

Cluster Syntax Features

Descriptive Terms
temperatur 2.5%, reaction 2.4%, complex 2.4%, film 1.9%, ion 1.6%, acid 1.6%, compound 1.5%, structur 1.3%, crystal 1.3%, oxid 1.1%, phase 1.0%, composit 0.9%, concentr 0.8%, synthes 0.8%, dot 0.8%, synthesi 0.8%, center 0.8%, catalyst 0.7%, bond 0.7%, (25.57%)

Single Word Terms
temperatur 1557, structur 1249, reaction 1105, acid 1006, concentr 927, electron 875, properti 852, two 849, form 842, activ 814, compound 799, solut 799, ion 790, synthes 776, high 771, phase 771, complex 770, rai 737, format 709, composit 698

Double Word Terms
rai.diffract 444, room.temperatur 359, electron.microscopi 256, hydrogen.bond 253, scan.electron 228, thin.film 195, crystal.structur 191, activ.energi 186, aqueou.solut 178, singl.crystal 172, solid.state 160, first.order 157, titl.compound 152, metal.ion 140, particl.size 136, transmiss.electron 132, transit.temperatur 129, diffract.xrd 126, differenti.scan 120, low.temperatur 115

Triple Word Terms
scan.electron.microscopi 150, rai.diffract.xrd 118, transmiss.electron.microscopi 98, differenti.scan.calorimetri 96, fourier.transform.infrar 94, electron.microscopi.sem 62, glass.transit.temperatur 60, singl.crystal.rai 60, powder.rai.diffract 59, intermolecular.hydrogen.bond 51, scan.electron.microscop 51, verlag.gmbh.kgaa 48, atom.forc.microscopi 46, center.dot.hydrogen 46, transform.infrar.spectroscopi 45, vch.verlag.gmbh 45, solid.state.reaction 42, optic.band.gap 41, scan.calorimetri.dsc 40, first.order.kinet 39

Cluster Metrics

Authors
kumar, a 62; kumar, s 56; kumar, r 46; ravikumar, k 44; singh, s 32; singh, ak 32; singh, b 31; ghosh, s 30; yadav, js 28; velmurugan, d 28; sharma, s 28; sharma, r 27; chandra, s 27; basu, s 27; das, s 26; malik, sk 25; kumar, p 24; thomas, s 23; mukherjee, t 23; avasthi, dk 23

Sources
asian journal of chemistry 204; tetrahedron letters 153; journal of the indian chemical society 138; acta crystallographica section e-structure reports online 127; indian journal of chemistry section b-organic chemistry including medicinal chemistry 118; journal of applied physics 76; journal of applied polymer science 72; spectrochimica acta part a-molecular and biomolecular spectroscopy 71; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 64; bulletin of

materials science 56; synthetic communications 54; journal of polymer materials 54; journal of molecular catalysis a-chemical 54; indian journal of heterocyclic chemistry 53; journal of physical chemistry b 51; transition metal chemistry 50; pramana-journal of physics 50; indian journal of physics and proceedings of the indian association for the cultivation of science 50; materials letters 48; journal of colloid and interface science 44

Keywords
chemistry, multidisciplinary 723; chemistry, organic 638; chemistry, physical 514; materials science, multidisciplinary 470; polymer science 295; chemistry, inorganic & nuclear 276; crystallography 250; chemistry, analytical 207; derivatives 205; physics, condensed matter 183; materials science, multidisciplinary 165; physics, applied 161; behavior 153; acid 152; physics, multidisciplinary 150; kinetics 147; physics, condensed matter 146; oxidation 137; chemistry, applied 136; spectroscopy 132

Publication Year
2005 4905; 2006 143; 2004 56

Country
india 5104; usa 172; germany 131; japan 108; france 66; england 62; south korea 55; peoples r china 41; taiwan 39; spain 38; italy 32; malaysia 22; canada 19; switzerland 17; australia 16; poland 12; netherlands 12; scotland 10; denmark 9; czech republic 9

Institution
indian inst technol 625; indian inst sci 260; indian inst chem technol 217; natl chem lab 181; bhabha atom res ctr 177; indian assoc cultivat sci 124; jadavpur univ 100; univ madras 99; anna univ 99; univ delhi 94; csir 77; tata inst fundamental res 75; banaras hindu univ 71; univ hyderabad 70; aligarh muslim univ 62; univ mysore 59; sri venkateswara univ 57; natl inst technol 56; univ bombay 53; natl phys lab 52

DataBase
science citation index 5104

Citations
spek al, 2003, j appl crystallogr 1, v36, p7 104; farrugia lj, 1997, j appl crystallogr, v30, p565 85; sheldrick gm, 1997, shelxs97 shelxl97 81; geary wj, 1971, coordin chem rev, v7, p81 55; nardelli m, 1995, j appl crystallogr, v28, p659 52; otwinowski z, 1997, method enzymol, v276, p307 43; sheldrick gm, 1990, acta crystallogr a, v46, p467 41; north act, 1968, acta crystallogr a, v24, p351 37; cremer d, 1975, j am chem soc, v97, p1354 37; sheldrick gm, 1997, shelxl97 35; bernstein j, 1995, angew chem int edit, v34, p1555 35; lever abp, 1984, inorganic elect spec 33; welton t, 1999, chem rev, v99, p2071 32; farrugia lj, 1999, j appl crystallogr, v32, p837 30; sheldrick gm, 1997, shelxl 97 program re 29; shannon rd, 1976, acta crystallogr a, v32, p751 27; allen fh, 1987, j chem soc p2, s1 26; lehn jm, 1995, supramolecular chem 25; sheldon r, 2001, chem commun, p2399 23; nakamoto k, 1978, infrared raman spect 22

**LEVEL 3**

CLUSTER 21

- **ANIMAL EXPERIMENTS; PLANT BIOLOGY**

(1458 Records)

Cluster Syntax Features

Descriptive Terms
rat 3.8%, extract 3.5%, plant 3.1%, level 2.4%, seed 2.2%, acid 1.8%, antioxid 1.8%, oil 1.6%, induc 1.5%, activ 1.5%, treatment 1.4%, content 1.3%, dose 1.3%, root 1.1%, concentr 1.1%, enzym 0.9%, shoot 0.9%, growth 0.9%, glutathion 0.8%, (33.67%)

Single Word Terms
level 506, activ 455, acid 428, induc 401, treatment 381, concentr 370, control 366, reduc 360, content 319, plant 313, rat 310, extract 308, treat 276, dose 269, weight 267, total 266, product 266, enzym 240, growth 237, bodi 222

Double Word Terms
lipid.peroxid 154, bodi.weight 154, superoxid.dismutas 107, oxid.stress 91, glutathion.peroxidas 76, antioxid.enzym 72, reduc.glutathion 66, free.radic 63, oral.administr 57, ascorb.acid 57, glutathion.gsh 56, dose.depend 56, glutathion.transferas 55, dismutas.sod 55, thiobarbitur.acid 51, fatti.acid 49, alkalin.phosphatas 49, wistar.rat 48, treat.rat 47, experi.conduct 46

Triple Word Terms
superoxid.dismutas.sod 55, thiobarbitur.acid.reactiv 43, acid.reactiv.substanc 42, dismutas.sod.catalas 33, reduc.glutathion.gsh 32, level.lipid.peroxid 32, reactiv.substanc.tbar 31, reactiv.oxygen.speci 31, glutathion.transferas.gst 31, superoxid.dismutas.catalas 30, lipid.peroxid.lpo 28, murashig.skoog.medium 28, induc.oxid.stress 28, glutathion.peroxidas.gpx 28, male.wistar.rat 26, sod.catalas.cat 26, 100.bodi.weight 26, dose.depend.manner 24, spragu.dawlei.rat 23, catalas.glutathion.peroxidas 22

Cluster Metrics

Authors
kumar, s 20; singh, s 18; singh, r 16; kumar, a 15; sharma, s 14; varalakshmi, p 13; kumar, r 13; gupta, sk 13; sharma, a 11; subramanian, s 10; srivastava, ak 10; singh, m 10; menon, vp 10; kumar, d 10; singh, b 9; sharma, p 9; bawa, as 9; singh, a 8; sharma, rk 8; panneerselvam, c 8

Sources
journal of food science and technology-mysore 117; asian journal of chemistry 39; molecular and cellular biochemistry 36; indian journal of animal sciences 35; journal of environmental biology 27; phytotherapy research 21; in vitro cellular & developmental

biology-plant 21; journal of essential oil research 18; indian veterinary journal 18; journal of ethnopharmacology 17; world journal of microbiology & biotechnology 16; current science 15; food chemistry 14; chemosphere 14; pharmaceutical biology 13; indian journal of chemistry section b-organic chemistry including medicinal chemistry 13; life sciences 12; journal of the science of food and agriculture 12; indian journal of agricultural sciences 12; bioresource technology 12

Keywords
food science & technology 160; pharmacology & pharmacy 113; pharmacology & pharmacy 100; plant sciences 96; environmental sciences 90; plant sciences 86; chemistry, medicinal 84; biochemistry & molecular biology 84; oxidative stress 82; growth 80; agriculture, dairy & animal science 69; toxicology 67; glutathione 64; chemistry, multidisciplinary 63; cell biology 63; chemistry, applied 62; biotechnology & applied microbiology 62; rats 62; lipid-peroxidation 59; acid 55

Publication Year
2005 1379; 2006 50; 2004 27; 2003 1; 2002 1

Country
india 1458; usa 47; japan 17; south korea 16; germany 15; france 10; england 9; peoples r china 8; hungary 8; canada 8; netherlands 4; kuwait 4; italy 3; philippines 2; pakistan 2; malaysia 2; bangladesh 2; australia 2; argentina 2; yemen 1

Institution
univ madras 69; cent food technol res inst 42; annamalai univ 42; punjab agr univ 40; indian vet res inst 31; bhabha atom res ctr 30; univ delhi 28; indian inst technol 28; panjab univ 24; indian agr res inst 24; natl dairy res inst 22; aligarh muslim univ 22; ind toxicol res ctr 20; cent drug res inst 18; csir 17; banaras hindu univ 17; all india inst med sci 17; univ rajasthan 16; jadavpur univ 16; hamdard univ 16

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Citations
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CLUSTER 7

- **CELL BIOLOGY/ GENETICS**

(1168 Records)

Cluster Syntax Features

Descriptive Terms
cell 11.2%, protein 8.8%, activ 4.8%, gene 4.0%, express 3.5%, dna 1.9%, enzym 1.8%, strain 1.5%, inhibit 1.4%, sequenc 1.3%, isol 1.2%, bind 0.9%, compound 0.8%, human 0.7%, induc 0.7%, vitro 0.7%, transcript 0.6%, immun 0.5%, kda 0.5%, acid 0.5%

Discriminating Terms
cell 8.4%, protein 6.7%, gene 3.0%, express 2.6%, activ 2.0%, dna 1.2%, enzym 1.2%, temperatur 0.9%, inhibit 0.9%, strain 0.8%, sequenc 0.7%, model 0.6%, patient 0.5%, film 0.5%, transcript 0.5%, phase 0.5%, isol 0.5%, kda 0.5%, bind 0.5%, paramet 0.5%

Single Word Terms
activ 546, cell 499, protein 486, express 321, gene 281, inhibit 248, two 247, level 246, acid 239, role 238, induc 231, isol 210, sequenc 207, function 203, human 201, enzym 199, vitro 196, high 187, on 185, dna 185

Double Word Terms
amino.acid 107, escherichia.coli 91, cell.line 70, molecular.weight 57, plai.role 57, gene.express 56, sd.page 54, mycobacterium.tuberculosi 52, western.blot 46, immun.respons 46, wild.type 41, enzym.activ 40, first.time 39, cancer.cell 35, depend.manner 35, molecular.mass 35, protein.kinas 33, transcript.factor 32, dose.depend 31, activ.enzym 30

Triple Word Terms
polymeras.chain.reaction 28, amino.acid.sequenc 24, cancer.cell.line 22, open.read.frame 21, chain.reaction.pcr 20, amino.acid.residu 18, reactiv.oxygen.speci 18, dose.depend.manner 17, express.escherichia.coli 16, activ.protein.kinas 15, low.molecular.weight 15, molecular.mass.kda 14, link.immunosorb.assai 14, molecular.weight.kda 14, enzym.link.immunosorb 14, mitogen.activ.protein 12, gel.filtrat.chromatographi 12, gram.posit.gram 11, polyacrylamid.gel.electrophoresi 11, posit.gram.neg 11

Term Cliques
15.84% sequenc isol human kda
16.22% strain sequenc isol kda acid
17.89% enzym inhibit compound acid
16.20% enzym strain compound acid
16.08% enzym strain isol kda acid
15.78% dna bind human induc vitro immun
15.70% dna strain vitro

18.56% gene dna sequenc isol human
18.42% gene dna strain sequenc isol acid
19.43% activ bind human induc vitro immun kda
24.40% activ inhibit compound vitro
21.12% activ inhibit bind human induc vitro kda
22.11% activ strain vitro kda
22.71% activ strain compound vitro
24.46% activ enzym inhibit compound
22.17% activ enzym strain kda
22.77% activ enzym strain compound
21.08% protein enzym inhibit bind kda acid
22.23% protein express sequenc bind kda acid
21.69% protein express sequenc bind human kda
22.82% protein express inhibit bind kda acid
22.76% protein express inhibit bind transcript acid
21.00% protein express dna bind human induc immun
21.47% protein gene express dna bind human induc transcript
21.62% protein gene express dna sequenc bind transcript acid
21.21% protein gene express dna sequenc bind human transcript
25.46% protein activ enzym inhibit bind kda
23.54% protein activ express bind human induc immun kda
25.02% protein activ express inhibit bind human induc kda
24.98% protein activ express inhibit bind human induc transcript
20.29% cell dna human induc vitro immun
25.44% cell activ human induc vitro immun
27.41% cell activ inhibit human induc vitro
24.87% cell protein express dna human induc immun
24.96% cell protein express dna human induc transcript
29.28% cell protein activ express human induc immun
28.36% cell protein activ express inhibit human induc transcript

Cluster Metrics

Authors
das, s 17; gupta, s 16; sinha, s 14; kumar, a 14; singh, s 13; singh, r 13; sharma, s 13; kumar, s 13; sharma, a 11; puri, sk 11; kumar, r 11; gupta, sk 11; tyagi, ak 10; pandey, a 10; srivastava, k 9; singh, j 9; singh, a 9; prasad, r 9; gupta, a 9; yogeeswari, p 8

Sources
biochemical and biophysical research communications 43; bioorganic & medicinal chemistry letters 32; current science 29; molecular and cellular biochemistry 24; nucleic acids research 19; journal of biological chemistry 19; world journal of microbiology & biotechnology 17; indian journal of animal sciences 16; bioorganic & medicinal chemistry 14; indian journal of biochemistry & biophysics 12; febs letters 12; indian veterinary journal 11; asian journal of chemistry 11; international journal of systematic and evolutionary microbiology 10; european journal of medicinal chemistry 10;

biochemical journal 10; plant science 9; enzyme and microbial technology 9; medicinal chemistry research 8; journal of immunology 8

Keywords
biochemistry & molecular biology 284; biophysics 103; biotechnology & applied microbiology 92; expression 92; chemistry, medicinal 82; proteins 63; immunology 62; microbiology 58; cells 58; identification 55; protein 53; purification 52; chemistry, organic 50; in-vitro 48; gene 48; binding 48; cell biology 47; escherichia-coli 47; microbiology 46; sequence 44

Publication Year
2005 1119; 2006 29; 2004 20

Country
india 1168; usa 98; germany 39; japan 27; england 22; south korea 9; france 9; italy 8; peoples r china 7; hungary 7; australia 7; switzerland 5; sweden 5; taiwan 4; spain 4; iran 4; canada 4; brazil 4; south africa 3; singapore 3

Institution
indian inst sci 58; cent drug res inst 45; indian inst technol 42; univ delhi 39; jawaharlal nehru univ 38; ctr cellular & mol biol 37; bose inst 30; all india inst med sci 25; natl inst immunol 24; indian inst chem biol 23; indian agr res inst 23; tata inst fundamental res 22; int ctr genet engn & biotechnol 21; indian vet res inst 21; bhabha atom res ctr 21; banaras hindu univ 20; aligarh muslim univ 20; postgrad inst med educ & res 19; univ hyderabad 18; inst microbial technol 18

DataBase
science citation index 1168

Citations
laemmli uk, 1970, nature, v227, p680 115; lowry oh, 1951, j biol chem, v193, p265 95; sambrook j, 1989, mol cloning lab manu 80; bradford mm, 1976, anal biochem, v72, p248 58; altschul sf, 1997, nucleic acids res, v25, p3389 43; towbin h, 1979, p natl acad sci usa, v76, p4350 32; thompson jd, 1994, nucleic acids res, v22, p4673 30; murashige t, 1962, physiol plantarum, v15, p473 23; altschul sf, 1990, j mol biol, v215, p403 21; sambrook j, 2001, mol cloning lab manu 18; cole st, 1998, nature, v393, p537 18; mosmann t, 1983, j immunol methods, v65, p55 16; thompson jd, 1997, nucleic acids res, v25, p4876 14; lambros c, 1979, j parasitol, v65, p418 14; trager w, 1976, science, v193, p673 13; smith pk, 1985, anal biochem, v150, p76 12; lowry oh, 1951, j biol chem, v193, p275 12; kimura m, 1980, j mol evol, v16, p111 12; dubois m, 1956, anal chem, v28, p350 12; chomczynski p, 1987, anal biochem, v162, p156 12

CLUSTER 5

- **HUMAN PATIENT DISEASES**

(1218 Records)

Cluster Syntax Features

Descriptive Terms
patient 30.4%, diseas 1.9%, infect 1.7%, clinic 1.6%, women 1.3%, children 1.3%, ag 1.2%, diagnosi 1.0%, hiv 1.0%, treatment 0.9%, surgeri 0.8%, case 0.8%, therapi 0.7%, risk 0.6%, lesion 0.6%, test 0.6%, control 0.6%, mean 0.6%, ey 0.6%, complic 0.5%

Discriminating Terms
patient 21.7%, diseas 1.1%, clinic 1.1%, temperatur 0.9%, women 0.9%, children 0.9%, infect 0.9%, model 0.8%, diagnosi 0.7%, hiv 0.7%, complex 0.6%, ag 0.6%, acid 0.6%, structur 0.6%, surgeri 0.6%, compound 0.5%, activ 0.5%, reaction 0.5%, therapi 0.5%, ion 0.4%

Single Word Terms
patient 736, on 327, clinic 316, two 313, ag 312, diseas 304, treatment 267, background 254, control 242, case 240, mean 230, infect 222, high 211, posit 208, diagnosi 201, total 196, rate 187, three 182, test 177, factor 171

Double Word Terms
mean.ag 57, patient.patient 55, two.patient 50, on.patient 48, risk.factor 48, three.patient 42, four.patient 39, hiv.infect 37, male.femal 36, magnet.reson 36, on.hundr 34, odd.ratio 34, confid.interv 33, patient.control 33, patient.mean 31, ag.sex 31, logist.regress 30, reson.imag 28, patient.on 27, tertiari.care 27

Triple Word Terms
magnet.reson.imag 28, polymeras.chain.reaction 21, bodi.mass.index 20, human.immunodefici.viru 19, ratio.confid.interv 17, odd.ratio.confid 16, fine.needl.aspir 16, central.nervou.system 16, ag.sex.match 16, immunodefici.viru.hiv 14, mass.index.bmi 14, squamou.cell.carcinoma 14, sex.match.control 13, world.health.organ 13, correct.visual.acuiti 13, acid.fast.bacilli 13, diseas.free.surviv 13, enzym.link.immunosorb 12, link.immunosorb.assai 12, reson.imag.mri 11

Term Cliques
14.32% treatment case therapi lesion complic
13.86% treatment surgeri case ey complic
15.09% treatment surgeri case therapi complic
15.97% diagnosi treatment case ey
15.44% diagnosi treatment case therapi lesion
15.73% women ag risk mean complic
14.33% women ag therapi risk complic
12.86% infect women therapi risk complic
18.59% diseas children ag risk mean
17.72% diseas children ag risk test
18.76% diseas women ag risk control mean
17.16% diseas women ag therapi risk test control

21.22% diseas clinic children ag mean
19.70% diseas clinic children ag diagnosi test
16.24% diseas infect hiv treatment therapi risk test control
16.24% diseas infect children risk test
14.80% diseas infect women hiv therapi risk test control
17.88% diseas infect clinic hiv treatment therapi test control
18.47% diseas infect clinic children diagnosi test
23.86% patient treatment lesion mean complic
22.46% patient treatment therapi lesion complic
22.33% patient ag treatment risk mean ey complic
23.93% patient ag treatment therapi risk complic
22.07% patient ag treatment surgeri mean ey complic
26.29% patient ag treatment surgeri control mean
23.63% patient ag treatment surgeri therapi complic
25.12% patient ag treatment surgeri therapi control
26.04% patient ag diagnosi treatment ey
27.29% patient clinic ag treatment mean complic
26.12% patient clinic ag treatment therapi complic
22.70% patient infect treatment therapi risk complic
24.89% patient infect clinic treatment therapi complic
26.67% patient diseas treatment lesion mean
23.81% patient diseas diagnosi treatment therapi lesion
26.35% patient diseas ag treatment risk control mean
24.00% patient diseas ag treatment therapi risk test control
28.23% patient diseas clinic ag treatment control mean
25.65% patient diseas clinic ag treatment therapi test control
25.23% patient diseas clinic ag diagnosi treatment therapi test
23.08% patient diseas infect treatment therapi risk test control
24.72% patient diseas infect clinic treatment therapi test control
24.30% patient diseas infect clinic diagnosi treatment therapi test

Cluster Metrics

Authors
kumar, a 29; srivastava, a 24; singh, r 22; kumar, r 22; kumar, s 20; sharma, a 18; gupta, ak 17; gupta, v 16; gupta, s 14; singh, s 13; singh, n 13; sharma, n 12; gupta, rk 12; saxena, r 11; purkayastha, s 11; bhattacharya, sk 11; agarwal, a 11; pandey, rm 10; mahapatra, ak 10; gupta, a 10

Sources
indian journal of medical research 34; indian veterinary journal 22; national medical journal of india 17; neurology india 14; journal of clinical neuroscience 12; journal of tropical pediatrics 11; anesthesia and analgesia 11; acta cytologica 11; surgical laparoscopy endoscopy & percutaneous techniques 10; pediatric surgery international 10; pediatric neurosurgery 10; journal of endourology 10; journal of clinical microbiology

10; annals of thoracic surgery 10; rivista di neuroradiologia 9; journal of laryngology and otology 9; international journal of dermatology 9; american journal of ophthalmology 9; tropical medicine & international health 8; medicine science and the law 8

Keywords
surgery 146; india 94; clinical neurology 82; ophthalmology 76; public, environmental & occupational health 71; occupational health 71; public, environmental & 71; medicine, general & internal 70; immunology 61; children 53; surgery 52; diagnosis 52; radiology, nuclear medicine & medical imaging 49; pediatrics 49; pediatrics 49; prevalence 47; tropical medicine 46; cardiac & cardiovascular systems 41; urology & nephrology 40; hematology 40

Publication Year
2005 1176; 2006 21; 2004 21

Country
india 1218; usa 129; england 67; canada 23; france 20; germany 18; australia 17; italy 16; japan 14; switzerland 13; peoples r china 12; sweden 10; spain 10; netherlands 10; brazil 9; thailand 8; singapore 8; argentina 7; vietnam 6; south korea 6

Institution
all india inst med sci 170; postgrad inst med educ & res 82; christian med coll & hosp 66; sanjay gandhi postgrad inst med sci 65; tata mem hosp 29; sree chitra tirunal inst med sci & technol 29; univ delhi 20; natl inst mental hlth & neurosci 20; king georges med univ 20; maulana azad med coll 19; lv prasad eye inst 16; kasturba med coll & hosp 16; univ coll med sci 15; indian council med res 15; safdarjang hosp 13; who 12; natl inst cholera & enter dis 12; icmr 12; univ calif san francisco 10; king edward mem hosp 10

DataBase
science citation index 1218

Citations
wild s, 2004, diabetes care, v27, p1047 10; miller sa, 1988, nucleic acids res, v16, p1215 9; ramachandran a, 2001, diabetologia, v44, p1094 8; matthews dr, 1985, diabetologia, v28, p412 8; friedewald wt, 1972, clin chem, v18, p499 8; gavin jr, 1997, diabetes care, v20, p1183 6; deepa m, 2003, j assoc physician i, v51, p863 6; rodeghiero f, 1987, blood, v69, p454 5; mohan v, 2001, j am coll cardiol, v38, p682 5; khatri gr, 2002, new engl j med, v347, p1420 5; kaplan el, 1958, j am stat assoc, v53, p457 5; jacob a, 1998, ind j ophthalmol, v46, p81 5; eisenach kd, 1990, j infect dis, v161, p977 5; cleeman ji, 2001, jama-j am med assoc, v285, p2486 5; chandalia m, 1999, j clin endocr metab, v84, p2329 5; black hr, 1997, arch intern med, v157, p2413 5; bhave g, 1995, aids s1, v9, s21 5; banerji ma, 1999, j clin endocr metab, v84, p137 5; alberti kgmm, 1998, diabetic med, v15, p539 5; *who, 2001, world hlth rep 2001 5

CLUSTER 17

- **GEOLOGICAL RESEARCH; AGRICULTURAL RESEARCH; MATERIAL MECHANICS**

(1669 Records)

Cluster Syntax Features

Descriptive Terms
speci 3.0%, soil 2.7%, indian 1.6%, water 1.5%, area 1.3%, crop 1.2%, popul 1.1%, region 1.1%, season 0.9%, monsoon 0.8%, sediment 0.8%, genet 0.8%, model 0.7%, polymorph 0.7%, high 0.7%, river 0.6%, gene 0.6%, sea 0.6%, level 0.6%, (21.98%)

Single Word Terms
high 402, two 390, data 337, region 335, level 314, area 310, indian 297, on 292, water 287, three 260, speci 253, model 250, rate 243, total 241, system 241, low 237, time 235, paper 232, condit 232, product 231

Double Word Terms
experi.conduct 84, field.experi 63, sampl.collect 52, winter.season 44, arabian.sea 44, chain.reaction 42, polymeras.chain 41, west.bengal 40, grain.yield 40, indian.ocean 39, first.time 33, larg.scale 33, crop.system 33, genet.divers 32, organ.carbon 32, wheat.triticum 31, bai.bengal 30, monsoon.season 29, new.speci 29, posit.correl 29

Triple Word Terms
field.experi.conduct 45, polymeras.chain.reaction 41, rice.oryza.sativa 26, wheat.triticum.aestivum 26, fragment.length.polymorph 23, amplifi.polymorph.dna 22, chain.reaction.pcr 21, sea.surfac.temperatur 19, polymorph.dna.rapd 17, restrict.fragment.length 16, emend.fiori.paol 16, triticum.aestivum.emend 16, random.amplifi.polymorph 15, surfac.temperatur.sst 13, aestivum.emend.fiori 13, aerosol.optic.depth 12, indian.summer.monsoon 12, maiz.zea.mai 11, clai.loam.soil 10, mustard.brassica.juncea 10

Cluster Metrics

Authors
kumar, s 23; singh, s 18; kumar, a 18; mannan, sl 15; bhattacharya, sk 14; singh, r 13; sharma, a 11; kumar, r 11; ghosh, s 11; rao, kbs 10; karunasagar, i 10; gupta, ak 10; singh, sk 9; singh, m 9; sharma, r 9; saha, a 9; kumar, n 9; singh, vk 8; raj, b 8; das, sk 8

Sources
current science 114; journal of the geological society of india 71; indian journal of agronomy 39; indian veterinary journal 35; transactions of the indian institute of metals 34; indian journal of agricultural sciences 28; geophysical research letters 25; indian journal of animal sciences 24; journal of earth system science 22; environmental monitoring and assessment 22; environmental geology 18; atmospheric environment 17; international journal of remote sensing 15; euphytica 14; journal of environmental biology 13; asian journal of chemistry 13; materials science and technology 12; journal of

asian earth sciences 12; indian journal of marine sciences 12; deep-sea research part ii-topical studies in oceanography 12

Keywords
geosciences, multidisciplinary 160; india 135; multidisciplinary sciences 124; agronomy 113; environmental sciences 83; materials science, multidisciplinary 65; environmental sciences 65; water resources 53; veterinary sciences 50; metallurgy & metallurgical engineering 49; agriculture, dairy & animal science 46; plant sciences 46; agriculture, multidisciplinary 43; evolution 43; model 35; geochemistry & geophysics 34; oceanography 33; engineering, civil 33; growth 33; plant sciences 32

Publication Year
2005 1598; 2004 42; 2006 28; 2002 1

Country
india 1669; usa 109; germany 44; england 41; japan 34; australia 30; peoples r china 24; france 18; canada 17; south korea 11; italy 11; scotland 9; netherlands 9; thailand 8; switzerland 7; sweden 7; spain 7; mexico 7; belgium 7; brazil 6

Institution
indian inst technol 163; indian inst sci 56; natl inst oceanog 51; natl geophys res inst 49; indian agr res inst 34; indira gandhi ctr atom res 33; bhabha atom res ctr 33; univ delhi 26; phys res lab 24; indian stat inst 21; banaras hindu univ 21; geol survey india 20; univ calcutta 19; punjab agr univ 19; jawaharlal nehru univ 18; int crops res inst semi arid trop 18; indian vet res inst 18; anna univ 18; all india inst med sci 18; jadavpur univ 17

DataBase
science citation index 1669

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CLUSTER 14

- **ALGORITHMS/ NETWORK MODELING**

(1372 Records)

Cluster Syntax Features

Descriptive Terms
algorithm 6.3%, model 5.9%, network 3.4%, system 3.3%, paper 3.2%, optim 2.2%, design 1.8%, simul 1.7%, oper 1.4%, set 1.4%, control 1.1%, time 1.1%, data 0.9%, comput 0.9%, power 0.9%, gener 0.8%, fuzzi 0.8%, paramet 0.8%, neural 0.7%, filter 0.7%

Discriminating Terms
algorithm 6.1%, network 3.0%, model 2.9%, paper 2.1%, optim 1.7%, design 1.3%, system 1.3%, simul 1.2%, acid 1.1%, patient 0.9%, oper 0.9%, set 0.8%, fuzzi 0.8%, temperatur 0.8%, reaction 0.8%, activ 0.7%, compound 0.7%, neural 0.7%, neural.network 0.7%, filter 0.7%

Single Word Terms
paper 644, model 482, system 465, time 345, two 333, algorithm 314, simul 306, data 298, gener 284, design 269, set 268, paramet 266, oper 256, optim 256, on 255, function 238, control 225, comput 223, applic 218, new 217

Double Word Terms
neural.network 104, genet.algorithm 67, artifici.neural 49, data.set 42, real.time 42, non.linear 41, model.model 35, network.model 35, paper.new 33, steadi.state 31, mathemat.model 31, two.dimension 28, network.ann 28, paper.deal 25, experiment.data 25, finit.element 25, input.output 23, simul.model 22, mean.squar 22, simul.anneal 22

Triple Word Terms
artifici.neural.network 48, neural.network.ann 28, neural.network.model 27, signal.nois.ratio 14, mean.squar.error 14, mont.carlo.simul 11, neural.network.train 10, sort.genet.algorithm 10, root.mean.squar 9, particl.swarm.optim 9, propag.neural.network 8, plai.vital.role 8, model.experiment.data 8, support.vector.machin 8, genet.algorithm.nsga 8, simul.anneal.algorithm 7, algorithm.simul.anneal 7, back.propag.neural 7, non.domin.sort 7, feed.forward.back 7

Term Cliques
17.13% design simul oper time comput power filter
17.15% design simul oper control time power filter
21.10% paper oper comput gener fuzzi paramet
21.12% paper oper control gener fuzzi paramet
22.34% paper design simul oper control time power gener paramet
21.96% paper optim design simul oper time comput power gener paramet
23.52% system paper oper comput gener fuzzi
23.54% system paper oper control gener fuzzi
23.96% system paper design simul oper control time power gener
23.41% system paper optim design simul oper time comput power gener
18.78% network paper set control gener fuzzi paramet neural

21.34% network paper set control time gener paramet neural
21.68% network paper simul control time gener paramet neural
20.59% network system paper set control gener fuzzi neural
23.15% network system paper set control time gener neural
23.50% network system paper simul control time gener neural
22.67% model design simul control time gener paramet
22.15% model optim design simul time comput gener paramet
24.74% model system design simul control time gener
23.96% model system optim design simul time comput gener
17.30% model network set control gener fuzzi paramet neural
19.86% model network set control time gener paramet neural
20.21% model network simul control time gener paramet neural
19.11% model network system set control gener fuzzi neural
21.67% model network system set control time gener neural
22.02% model network system simul control time gener neural
23.69% algorithm paper optim set time comput gener paramet
24.03% algorithm paper optim simul time comput gener paramet
25.50% algorithm system paper optim set time comput gener
25.85% algorithm system paper optim simul time comput gener
19.22% algorithm network paper set comput gener fuzzi paramet neural
21.49% algorithm network paper set time comput gener paramet neural
21.80% algorithm network paper simul time comput gener paramet neural
20.83% algorithm network system paper set comput gener fuzzi neural
23.10% algorithm network system paper set time comput gener neural
23.41% algorithm network system paper simul time comput gener neural
22.21% algorithm model optim set time comput gener paramet
22.56% algorithm model optim simul time comput gener paramet
24.03% algorithm model system optim set time comput gener
24.37% algorithm model system optim simul time comput gener
18.29% algorithm model network set data comput gener fuzzi paramet neural
20.34% algorithm model network set time data comput gener paramet neural
20.61% algorithm model network simul time data comput gener paramet neural
19.74% algorithm model network system set data comput gener fuzzi neural
21.79% algorithm model network system set time data comput gener neural
22.06% algorithm model network system simul time data comput gener neural

Cluster Metrics

Authors
kumar, r 19; kumar, s 18; kumar, a 14; singh, s 12; chaudhuri, s 9; tiwari, mk 8; singh, r 8; singh, b 8; shah, na 8; mukherjee, s 8; mitra, s 8; rao, vr 7; gupta, v 7; gupta, p 7; gupta, a 7; ghosh, a 7; chakraborty, s 7; sinha, s 6; sarkar, p 6; roy, s 6

Sources
iete journal of research 27; microwave and optical technology letters 19; journal of scientific & industrial research 18; international journal of advanced manufacturing

technology 17; sadhana-academy proceedings in engineering sciences 14; journal of materials processing technology 13; indian journal of pure & applied physics 13; iete technical review 13; defence science journal 13; physical review e 10; international journal of production research 10; iee proceedings-electric power applications 10; electric power components and systems 10; materials and manufacturing processes 9; industrial & engineering chemistry research 9; communications in statistics-theory and methods 9; mathematical and computer modelling 8; journal of mathematical analysis and applications 8; indian journal of engineering and materials sciences 8; ieee transactions on power delivery 8

Keywords
engineering, electrical & electronic 224; telecommunications 67; mathematics, applied 64; computer science, artificial intelligence 59; design 52; engineering, chemical 51; engineering, industrial 48; model 46; computer science, interdisciplinary applications 44; automation & control systems 44; systems 42; engineering, mechanical 41; optimization 40; engineering, manufacturing 39; computer science, hardware & architecture 38; mathematics, applied 38; engineering, civil 37; optics 37; computer science, 37; statistics & probability 36

Publication Year
2005 1297; 2006 62; 2004 13

Country
india 1372; usa 124; peoples r china 33; england 24; canada 22; germany 18; france 18; south korea 15; singapore 14; japan 14; italy 13; australia 13; taiwan 8; netherlands 8; malaysia 7; sweden 6; spain 6; iran 5; saudi arabia 3; israel 3

Institution
indian inst technol 428; indian inst sci 103; indian stat inst 64; jadavpur univ 35; natl inst technol 31; ind technol inst 23; univ delhi 22; anna univ 22; tata inst fundamental res 18; banaras hindu univ 16; univ calcutta 15; indian inst management 13; iit 13; natl chem lab 12; psg coll technol 11; osmania univ 11; cochin univ sci & technol 11; bengal engn & sci univ 11; aligarh muslim univ 11; univ hyderabad 10

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science citation index 1372

Citations
goldberg de, 1989, genetic algorithms s 18; deb k, 2001, multiobjective optim 14; zadeh la, 1965, inform contr, v8, p338 12; holland jh, 1975, adaptation natural a 10; kennedy j, 1995, p ieee int c neur ne, v4, p1942 9; deb k, 2002, ieee t evolut comput, v6, p182 9; hornik k, 1989, neural networks, v2, p359 8; cybenko g, 1989, math control signal, v2, p303 8; coello cac, 2002, evolutionary algorit 8; deb k, 1995, optimization eng des 7; daubechies i, 1992, 10 lect wavelets 7; *asce task comm ap, 2000, j hydrol eng, v5, p115 7; haykin s, 1994, neural networks comp 6; bishop cm, 1995, neural networks patt 6; bezdek jc, 1981, pattern recognition 6; srinivas n, 1995, evolutionary computa, v2, p221

5; rao ss, 1996, eng optimization the 5; randic m, 1975, j am chem soc, v97, p6609 5; press wh, 1992, numerical recipes fo 5; pawlak z, 1991, rough sets theoretic 5

CLUSTER 18

- **MATHEMATICAL ANALYSIS**

(2319 Records)

Cluster Syntax Features

Descriptive Terms
equat 2.3%, field 2.1%, model 2.1%, energi 2.0%, wave 1.8%, flow 1.4%, state 1.3%, theori 1.2%, densiti 1.0%, veloc 0.9%, function 0.8%, solut 0.8%, mode 0.8%, paramet 0.8%, calcul 0.7%, numer 0.7%, two 0.7%, pressur 0.7%, experiment 0.7%, (23.49%)

Single Word Terms
model 652, two 629, energi 527, equat 476, paramet 472, field 457, data 421, function 415, state 410, system 401, experiment 401, order 370, on 360, time 349, theori 349, densiti 341, structur 339, solut 335, gener 332, number 323

Double Word Terms
magnet.field 110, cross.section 96, experiment.data 94, two.dimension 89, finit.element 76, boundari.condit 73, differenti.equat 62, three.dimension 57, ground.state 55, on.dimension 55, densiti.function 54, power.law 54, reynold.number 49, heat.transfer 49, electr.field 46, first.order 44, steadi.state 44, time.depend 44, phase.transit 41, black.hole 41

Triple Word Terms
densiti.function.theori 34, bell.detector.kekb 27, mont.carlo.simul 19, differenti.cross.section 19, order.shear.deform 17, partial.differenti.equat 17, shear.deform.theori 17, root.200.gev 16, navier.stoke.equat 16, fermilab.tevatron.collid 15, vertic.bar.vertic 15, excess.molar.volum 15, close.form.solut 14, ordinari.differenti.equat 14, bar.vertic.bar 14, mass.transfer.coeffici 13, collis.root.200 13, first.order.shear 13, heat.transfer.coeffici 13, collect.bell.detector 13

Cluster Metrics

Authors
abe, k 64; banerjee, s 59; kumar, a 54; li, j 52; zhang, zp 50; kumar, s 47; chen, a 42; kang, jh 41; villa, s 39; matsumoto, t 39; kim, hj 35; zhang, lm 34; yamauchi, m 34; yamashita, y 34; wang, ch 34; uno, s 34; uehara, s 34; tian, xc 34; teramoto, y 34; tanaka, m 34

Sources
physical review d 72; physical review letters 63; physical review b 62; physics letters b 54; physical review e 41; journal of chemical physics 37; pramana-journal of physics 36;

physics of plasmas 34; indian journal of pure & applied physics 31; astronomy & astrophysics 31; physical review c 30; astrophysical journal 30; journal of high energy physics 29; physical review a 28; physica b-condensed matter 27; indian journal of physics and proceedings of the indian association for the cultivation of science 27; journal of applied physics 26; journal of physics a-mathematical and general 24; modern physics letters a 21; international journal of heat and mass transfer 21

Keywords
physics, multidisciplinary 306; physics, atomic, molecular & chemical 142; physics, condensed matter 140; mechanics 134; physics, particles & fields 129; astronomy & astrophysics 126; physics, fluids & plasmas 124; model 108; mathematics, applied 104; engineering, mechanical 99; physics, nuclear 98; chemistry, physical 96; physics, applied 90; physics, particles & fields 85; thermodynamics 77; physics, mathematical 76; mathematics 74; systems 73; optics 70; chemistry, multidisciplinary 59

Publication Year
2005 2234; 2006 60; 2004 25

Country
india 2319; usa 320; germany 185; peoples r china 129; japan 126; france 126; russia 123; south korea 92; england 77; switzerland 66; poland 66; taiwan 65; italy 58; netherlands 56; brazil 56; australia 56; canada 48; sweden 41; czech republic 39; austria 39

Institution
indian inst technol 435; tata inst fundamental res 170; indian inst sci 167; panjab univ 90; bhabha atom res ctr 88; inst high energy phys 85; univ delhi 69; saha inst nucl phys 67; korea univ 67; univ sci & technol china 64; princeton univ 64; univ tokyo 58; inst theoret & expt phys 57; chinese acad sci 57; univ tsukuba 51; tokyo inst technol 51; brookhaven natl lab 49; jadavpur univ 48; indian stat inst 47; banaras hindu univ 47

DataBase
science citation index 2319

Citations
eidelman s, 2004, phys lett b, v592, p1 54; adler ss, 2003, phys rev lett, v91 44; kurokawa s, 2003, nucl instrum meth a, v499, p1 33; abashian a, 2002, nucl instrum meth a, v479, p117 33; sjostrand t, 2001, comput phys commun, v135, p238 24; lee c, 1988, phys rev b, v37, p785 23; fox gc, 1978, phys rev lett, v41, p1581 20; patankar sv, 1980, numerical heat trans 19; adams j, 2004, phys rev lett, v92 19; redlich o, 1948, ind eng chem, v40, p345 18; albrecht h, 1990, phys lett b, v241, p278 18; seiberg n, 1999, j high energy phys 17; parr rg, 1989, density functional t 16; becke ad, 1993, j chem phys, v98, p5648 16; kohn w, 1965, phys rev, v140, a1133 15; hohenberg p, 1964, phys rev b, v136, p864 15; frisch mj, 1998, gaussian 98 revision 15; adler ss, 2004, phys rev c, v69 15; adams j, 2003, phys rev lett, v91 15; spergel dn, 2003, astrophys j suppl s, v148, p175 14

CLUSTER 24

- **SURFACE PHYSICS/ CHEMISTRY**

(2867 Records)

Cluster Syntax Features

Descriptive Terms
film 4.5%, temperatur 4.2%, ion 2.1%, composit 1.9%, phase 1.9%, concentr 1.4%, properti 1.2%, crystal 1.1%, sampl 1.1%, glass 1.0%, solut 1.0%, conduct 1.0%, polym 0.9%, alloi 0.9%, surfac 0.8%, magnet 0.8%, thermal 0.8%, structur 0.7%, deposit 0.7%, (28.82%)

Single Word Terms
temperatur 1230, concentr 759, properti 728, structur 664, phase 663, composit 619, solut 617, electron 596, high 566, ion 545, sampl 542, rai 541, measur 515, surfac 501, paramet 496, energi 460, size 460, thermal 441, form 438, film 438

Double Word Terms
rai.diffract 378, electron.microscopi 249, room.temperatur 245, scan.electron 221, thin.film 194, activ.energi 154, aqueou.solut 145, particl.size 131, transmiss.electron 130, transit.temperatur 126, diffract.xrd 120, differenti.scan 113, low.temperatur 105, singl.crystal 102, mechan.properti 102, temperatur.depend 101, solid.state 100, fourier.transform 96, band.gap 95, high.temperatur 93

Triple Word Terms
scan.electron.microscopi 145, rai.diffract.xrd 113, transmiss.electron.microscopi 96, differenti.scan.calorimetri 90, fourier.transform.infrar 85, electron.microscopi.sem 61, glass.transit.temperatur 59, powder.rai.diffract 52, scan.electron.microscop 50, atom.forc.microscopi 46, optic.band.gap 41, transform.infrar.spectroscopi 41, energi.dispers.rai 38, solid.state.reaction 38, scan.calorimetri.dsc 37, electron.microscopi.tem 36, rai.photoelectron.spectroscopi 33, electron.microscop.sem 28, thin.film.deposit 27, poli.vinyl.alcohol 27

Cluster Metrics

Authors
kumar, s 42; kumar, a 36; malik, sk 25; basu, s 25; kumar, r 24; avasthi, dk 23; singh, s 21; kundu, s 20; thomas, s 19; singh, b 18; tyagi, ak 17; pal, a 17; mukherjee, t 17; gupta, a 17; ghosh, s 17; chatterjee, s 17; singh, ak 16; rao, jl 15; nigam, ak 15; nath, s 15

Sources
journal of applied physics 76; asian journal of chemistry 70; journal of applied polymer science 57; bulletin of materials science 56; indian journal of physics and proceedings of the indian association for the cultivation of science 49; pramana-journal of physics 48; materials letters 47; journal of polymer materials 46; physica b-condensed matter 43;

journal of colloid and interface science 41; journal of the indian chemical society 40; journal of physical chemistry b 40; physical review b 39; materials chemistry and physics 36; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 34; solid state communications 31; indian journal of pure & applied physics 29; spectrochimica acta part a-molecular and biomolecular spectroscopy 28; journal of materials science 28; journal of crystal growth 27

Keywords
materials science, multidisciplinary 462; chemistry, physical 301; chemistry, multidisciplinary 246; polymer science 244; physics, condensed matter 174; physics, applied 158; chemistry, analytical 151; physics, multidisciplinary 142; physics, condensed matter 141; materials science, multidisciplinary 140; behavior 127; physics, applied 120; temperature 111; films 99; water 92; adsorption 85; kinetics 80; system 79; engineering, chemical 79; materials science, ceramics 77

Publication Year
2005 2708; 2006 115; 2004 44

Country
india 2867; usa 99; japan 85; germany 83; south korea 50; france 43; england 24; peoples r china 22; taiwan 21; italy 16; canada 14; spain 11; australia 11; switzerland 7; malaysia 7; israel 7; brazil 7; russia 6; portugal 6; mexico 6

Institution
indian inst technol 431; indian inst sci 141; bhabha atom res ctr 135; indian assoc cultivat sci 82; natl chem lab 80; anna univ 72; tata inst fundamental res 66; univ delhi 51; jadavpur univ 50; banaras hindu univ 50; natl phys lab 49; indian inst chem technol 48; cent electrochem res inst 47; csir 45; cent glass & ceram res inst 39; sri venkateswara univ 38; ctr nucl sci 37; indira gandhi ctr atom res 35; aligarh muslim univ 33; cochin univ sci & technol 32

DataBase
science citation index 2867

Citations
shannon rd, 1976, acta crystallogr a, v32, p751 25; zener c, 1951, phys rev, v82, p403 19; kurtz sk, 1968, j appl phys, v39, p3798 19; alivisatos ap, 1996, science, v271, p933 17; macdonald jr, 1987, impedance spectrosco 16; jonscher ak, 1977, nature, v267, p673 16; kalyanasundaram k, 1977, j am chem soc, v99, p2039 14; weber wj, 1963, j sanitary engineeri, v89, p31 13; rao cnr, 1998, colossal magnetoresi 13; ofelt gs, 1962, j chem phys, v37, p511 13; lakowicz jr, 1999, principles fluoresce 13; hwang hy, 1996, phys rev lett, v77, p2041 13; henglein a, 1989, chem rev, v89, p1861 13; sarkar n, 1996, j phys chem-us, v100, p15483 12; oconnor dv, 1984, time correlated sing 12; millis aj, 1995, phys rev lett, v74, p5144 12; langmuir i, 1918, j am chem soc, v40, p1361 12; kreibig u, 1995, optical properties m 12; judd br, 1962, phys rev, v127, p750 12; jonscher ak, 1983, dielectric relaxatio 12

CLUSTER 25

- **COMPOUND CHEMISTRY**

(2237 Records)

Cluster Syntax Features

Descriptive Terms
complex 6.7%, reaction 6.0%, compound 2.9%, dot 2.7%, center 2.4%, acid 2.3%, synthesi 1.9%, catalyst 1.9%, yield 1.7%, ligand 1.6%, bond 1.5%, hydrogen 1.3%, substitut 1.2%, ring 1.2%, synthes 1.2%, structur 1.1%, oxid 1.0%, beta 0.8%, molecul 0.8%, (40.99%)

Single Word Terms
reaction 825, complex 599, structur 585, acid 576, compound 565, synthes 448, yield 444, activ 436, two 411, on 404, form 404, bond 383, synthesi 382, hydrogen 332, temperatur 327, ligand 315, crystal 314, interact 311, deriv 310, product 306

Double Word Terms
hydrogen.bond 229, crystal.structur 151, titl.compound 149, room.temperatur 114, schiff.base 88, spectral.data 87, first.order 85, reaction.condit 74, singl.crystal 70, metal.ion 66, rai.diffract 66, magnet.suscept 61, solid.state 60, high.yield 59, acet.acid 57, water.molecul 57, molar.conduct 54, amino.acid 54, on.pot 53, alpha.beta 52

Triple Word Terms
singl.crystal.rai 49, intermolecular.hydrogen.bond 47, center.dot.hydrogen 46, dot.hydrogen.bond 38, hydrogen.bond.interact 36, solvent.free.condit 32, magnet.suscept.measur 32, element.molar.conduct 28, reaction.first.order 28, alpha.beta.unsatur 27, vch.verlag.gmbh 25, center.dot.h2o 24, mass.spectral.data 23, verlag.gmbh.kgaa 23, van.der.waal 23, crystal.rai.diffract 23, gmbh.kgaa.69451 22, kgaa.69451.weinheim 22, nmr.mass.spectral 21, structur.titl.compound 20

Cluster Metrics

Authors
ravikumar, k 42; yadav, js 28; velmurugan, d 28; kumar, a 26; raghunathan, r 22; kumar, r 22; selvanayagam, s 20; sharma, r 18; nethaji, m 17; singh, ak 16; sharma, s 16; reddy, pn 16; sridhar, b 15; fun, hk 15; chandra, s 15; yadav, gd 14; kumar, s 14; singh, b 13; rajitha, b 13; rajaram, rk 13

Sources
tetrahedron letters 149; asian journal of chemistry 134; acta crystallographica section e-structure reports online 126; indian journal of chemistry section b-organic chemistry including medicinal chemistry 116; journal of the indian chemical society 98; synthetic communications 54; indian journal of heterocyclic chemistry 53; transition metal

chemistry 50; journal of molecular catalysis a-chemical 46; spectrochimica acta part a-molecular and biomolecular spectroscopy 43; journal of chemical research-s 43; tetrahedron 36; synlett 34; journal of organic chemistry 33; synthesis-stuttgart 30; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 30; inorganic chemistry 28; journal of heterocyclic chemistry 26; polyhedron 25; inorganica chimica acta 22

Keywords
chemistry, organic 621; chemistry, multidisciplinary 477; chemistry, inorganic & nuclear 259; chemistry, physical 213; crystallography 185; derivatives 184; chemistry, organic 106; complexes 105; acid 98; chemistry 97; oxidation 89; synthesis 83; crystal-structure 78; derivatives 73; ligands 69; kinetics 67; biochemistry & molecular biology 63; crystal-structure 61; alcohols 61; chemistry, applied 59

Publication Year
2005 2197; 2006 28; 2004 12

Country
india 2237; usa 73; germany 48; england 38; spain 27; japan 23; france 23; peoples r china 19; taiwan 18; italy 16; malaysia 15; switzerland 10; scotland 9; poland 8; denmark 8; netherlands 7; czech republic 7; south korea 5; canada 5; australia 5

Institution
indian inst technol 194; indian inst chem technol 169; indian inst sci 119; natl chem lab 101; univ madras 73; jadavpur univ 50; univ hyderabad 49; univ delhi 43; indian assoc cultivat sci 42; bhabha atom res ctr 42; cent drug res inst 39; univ mysore 38; bharathidasan univ 36; bangalore univ 34; univ rajasthan 33; csir 32; madurai kamaraj univ 31; aligarh muslim univ 29; univ bombay 27; natl inst technol 27

DataBase
science citation index 2237

Citations
spek al, 2003, j appl crystallogr 1, v36, p7 104; farrugia lj, 1997, j appl crystallogr, v30, p565 82; sheldrick gm, 1997, shelxs97 shelxl97 81; geary wj, 1971, coordin chem rev, v7, p81 55; nardelli m, 1995, j appl crystallogr, v28, p659 52; otwinowski z, 1997, method enzymol, v276, p307 42; sheldrick gm, 1990, acta crystallogr a, v46, p467 39; cremer d, 1975, j am chem soc, v97, p1354 37; bernstein j, 1995, angew chem int edit, v34, p1555 35; sheldrick gm, 1997, shelxl97 34; north act, 1968, acta crystallogr a, v24, p351 34; lever abp, 1984, inorganic elect spec 32; sheldrick gm, 1997, shelxl 97 program re 27; farrugia lj, 1999, j appl crystallogr, v32, p837 26; allen fh, 1987, j chem soc p2, s1 26; welton t, 1999, chem rev, v99, p2071 24; lehn jm, 1995, supramolecular chem 24; sheldrick gm, 1996, sadabs 21; desiraju gr, 1999, weak hydrogen bond s 21; caddick s, 1995, tetrahedron, v51, p10403 21

**LEVEL 4 – FINAL LEVEL**

CLUSTER 10

- **PLANT BIOLOGY**

(807 Records)

Cluster Syntax Features

Descriptive Terms
plant 6.9%, seed 5.1%, oil 3.4%, extract 3.2%, root 2.5%, acid 2.4%, shoot 2.4%, content 2.0%, growth 1.9%, product 1.4%, fruit 1.4%, medium 1.3%, leav 1.1%, cultur 1.1%, concentr 1.0%, soil 1.0%, germin 1.0%, isol 0.8%, supplement 0.8%, flour 0.8%

Discriminating Terms
plant 5.1%, seed 4.2%, oil 2.4%, shoot 2.1%, root 1.8%, extract 1.7%, fruit 1.1%, content 1.0%, model 1.0%, growth 0.9%, leav 0.9%, germin 0.8%, patient 0.8%, complex 0.8%, flour 0.7%, cultur 0.6%, reaction 0.6%, medium 0.6%, structur 0.6%, supplement 0.6%

Single Word Terms
plant 263, acid 252, content 223, concentr 206, growth 204, product 195, level 182, extract 160, reduc 158, total 154, activ 149, treatment 145, root 143, high 136, seed 132, medium 125, control 125, water 122, isol 120, chemic 119

Double Word Terms
medium.supplement 46, murashig.skoog 45, experi.conduct 38, ascorb.acid 37, plant.growth 36, physico.chemic 32, fatti.acid 31, essenti.oil 29, acet.acid 28, protein.content 28, dry.matter 28, skoog.medium 28, amino.acid 25, root.shoot 25, moistur.content 24, reduc.sugar 24, crude.protein 23, shoot.root 23, seed.germin 23, shelf.life 22

Triple Word Terms
murashig.skoog.medium 28, indol.butyr.acid 17, naphthaleneacet.acid.naa 15, total.solubl.solid 15, indol.acet.acid 15, half.strength.medium 14, field.experi.conduct 12, root.half.strength 11, alpha.naphthaleneacet.acid 11, skoog.medium.supplement 10, wheat.triticum.aestivum 10, rice.oryza.sativa 10, solid.state.ferment 10, shoot.root.half 9, basal.medium.supplement 9, solubl.solid.tss 9, acet.acid.iaa 9, bodi.weight.gain 8, cultur.murashig.skoog 8, ascorb.acid.content 8

Term Cliques
17.29% content product supplement flour
20.03% acid growth product medium cultur concentr soil supplement
19.48% acid content growth soil germin supplement
20.64% acid content growth leav concentr soil supplement
22.59% acid content growth product concentr soil supplement
17.89% root acid growth medium cultur soil isol supplement
17.43% root acid growth medium leav soil isol supplement

16.34% root acid shoot growth medium cultur soil germin supplement
18.24% root acid shoot growth medium cultur concentr soil supplement
17.83% root acid shoot growth medium leav concentr soil supplement
17.67% extract acid leav soil isol
19.80% extract acid leav concentr soil
17.97% oil product
14.04% oil extract leav
16.32% seed content flour
18.04% seed acid content fruit germin
18.46% seed acid content fruit leav
20.14% seed acid content growth soil germin
20.49% seed acid content growth leav soil
12.89% seed oil leav
19.70% plant content growth soil germin supplement
20.84% plant content growth leav concentr soil supplement
16.49% plant root shoot growth medium cultur soil germin supplement
18.39% plant root shoot growth medium cultur concentr soil supplement
17.98% plant root shoot growth medium leav concentr soil supplement
20.07% plant extract leav concentr soil
20.36% plant seed content growth soil germin
20.71% plant seed content growth leav soil

Cluster Metrics

Authors
singh, r 14; kumar, s 14; singh, s 9; gupta, sk 9; bawa, as 9; singh, b 7; kumar, a 7; sridhar, kr 6; singh, m 6; singh, g 6; sharma, p 6; sharma, a 6; kumar, d 6; gupta, ak 6; ansari, sh 6; singh, sp 5; singh, n 5; singh, j 5; sharma, s 5; sharma, r 5

Sources
journal of food science and technology-mysore 116; asian journal of chemistry 34; in vitro cellular & developmental biology-plant 21; journal of essential oil research 18; journal of environmental biology 16; world journal of microbiology & biotechnology 15; indian journal of animal sciences 15; current science 14; indian journal of chemistry section b-organic chemistry including medicinal chemistry 13; indian journal of agricultural sciences 12; bioresource technology 11; process biochemistry 10; journal of the science of food and agriculture 10; food chemistry 10; scientia horticulturae 9; journal of scientific & industrial research 9; chemosphere 9; biologia plantarum 9; asian-australasian journal of animal sciences 9; journal of the indian chemical society 8

Keywords
food science & technology 154; plant sciences 71; growth 67; plant sciences 64; chemistry, multidisciplinary 51; chemistry, applied 51; environmental sciences 50; biotechnology & applied microbiology 48; food science & technology 47; agriculture, dairy & animal science 40; plants 37; agriculture, multidisciplinary 29; storage 29;

quality 28; biochemistry & molecular biology 27; biotechnology & applied microbiology 26; agronomy 25; leaves 24; multidisciplinary sciences 22; cell biology 22

Publication Year
2005 742; 2006 38; 2004 25; 2003 1; 2002 1

Country
india 807; usa 16; south korea 13; japan 10; germany 10; france 7; england 6; hungary 5; peoples r china 4; netherlands 3; philippines 2; pakistan 2; italy 2; canada 2; bangladesh 2; australia 2; argentina 2; yemen 1; wales 1; thailand 1

Institution
punjab agr univ 30; cent food technol res inst 25; indian inst technol 24; indian agr res inst 21; univ delhi 18; cent inst med & aromat plants 15; guru nanak dev univ 14; bhabha atom res ctr 14; aligarh muslim univ 12; tamil nadu agr univ 11; csir 11; natl dairy res inst 10; natl bot res inst 10; govind ballabh pant univ agr & technol 10; def food res lab 10; univ calcutta 9; indian vet res inst 9; indian inst chem technol 9; haryana agr univ 9; bharathiar univ 9

DataBase
science citation index 807

Citations
murashige t, 1962, physiol plantarum, v15, p473 64; lowry oh, 1951, j biol chem, v193, p265 35; *aoac, 1990, off meth an 26; miller gl, 1959, anal chem, v31, p426 18; snedecor gw, 1989, stat methods 15; *aoac, 1984, off meth an 15; ranganna s, 1986, hdb anal quality con 14; gamborg ol, 1968, exp cell res, v50, p151 14; laemmli uk, 1970, nature, v227, p680 13; duncan db, 1955, biometrics, v11, p1 13; *aoac, 1980, off meth an 13; bates ls, 1973, plant soil, v39, p205 12; gomez ka, 1984, stat procedures agr 10; bradford mm, 1976, anal biochem, v72, p248 10; nelson n, 1944, j biol chem, v153, p375 9; lowry oh, 1951, j biol chem, v193, p275 9; dubois m, 1956, anal chem, v28, p350 9; davies nw, 1990, j chromatogr, v503, p1 9; amerine ma, 1965, principles sensory e 9; adams rp, 1989, identification essen 9

CLUSTER 3

- **ANIMAL EXPERIMENTS**

(651 Records)

Cluster Syntax Features

Descriptive Terms
rat 9.9%, antioxid 3.9%, induc 3.1%, level 2.9%, dose 2.5%, glutathion 2.2%, diabet 1.9%, lipid 1.9%, liver 1.7%, extract 1.7%, activ 1.6%, anim 1.4%, administr 1.4%, enzym 1.4%, peroxid 1.3%, treatment 1.3%, bodi 1.2%, lipid.peroxid 1.1%, mice 1.0%, treat 1.0%

Discriminating Terms
rat 7.4%, antioxid 2.9%, glutathion 1.6%, induc 1.5%, dose 1.5%, lipid 1.3%, liver 1.2%, diabet 1.2%, administr 1.0%, level 0.9%, peroxid 0.9%, temperatur 0.8%, anim 0.8%, lipid.peroxid 0.8%, bodi.weight 0.7%, mice 0.6%, enzym 0.6%, bodi 0.6%, structur 0.6%, extract 0.6%

Single Word Terms
induc 339, level 324, activ 306, rat 304, control 241, treatment 236, dose 227, reduc 202, treat 197, antioxid 194, lipid 192, administr 190, enzym 186, bodi 186, anim 179, acid 176, peroxid 168, concentr 164, weight 163, oxid 162

Double Word Terms
lipid.peroxid 151, bodi.weight 135, superoxid.dismutas 106, oxid.stress 87, glutathion.peroxidas 76, antioxid.enzym 70, reduc.glutathion 66, free.radic 62, glutathion.gsh 56, oral.administr 56, glutathion.transferas 55, dismutas.sod 54, dose.depend 48, wistar.rat 48, treat.rat 47, glutathion.reductas 46, alkalin.phosphatas 46, thiobarbitur.acid 43, catalas.cat 41, acid.reactiv 39

Triple Word Terms
superoxid.dismutas.sod 54, thiobarbitur.acid.reactiv 38, acid.reactiv.substanc 37, dismutas.sod.catalas 33, level.lipid.peroxid 32, reduc.glutathion.gsh 32, glutathion.transferas.gst 31, superoxid.dismutas.catalas 30, glutathion.peroxidas.gpx 28, induc.oxid.stress 28, reactiv.oxygen.speci 28, lipid.peroxid.lpo 28, sod.catalas.cat 26, reactiv.substanc.tbar 26, male.wistar.rat 26, 100.bodi.weight 24, spragu.dawlei.rat 23, catalas.glutathion.peroxidas 22, glutathion.peroxidas.glutathion 21, oxygen.speci.ro 21

Term Cliques
29.37% induc dose glutathion liver extract anim administr treatment bodi mice treat
31.40% induc dose glutathion liver extract activ administr treatment mice treat
32.70% rat induc dose glutathion lipid liver extract activ administr peroxid treatment lipid.peroxid treat
29.60% rat induc dose glutathion diabet lipid liver extract anim administr peroxid treatment bodi lipid.peroxid treat

32.65% rat induc level dose glutathion lipid liver anim administr enzym peroxid treatment bodi lipid.peroxid treat
34.33% rat induc level dose glutathion lipid liver activ administr enzym peroxid treatment lipid.peroxid treat
31.40% rat induc level dose glutathion diabet lipid liver anim administr peroxid treatment bodi lipid.peroxid treat
32.31% rat antioxid induc glutathion lipid liver extract activ administr peroxid treatment lipid.peroxid treat
29.26% rat antioxid induc glutathion diabet lipid liver extract anim administr peroxid treatment bodi lipid.peroxid treat
32.31% rat antioxid induc level glutathion lipid liver anim administr enzym peroxid treatment bodi lipid.peroxid treat
33.97% rat antioxid induc level glutathion lipid liver activ administr enzym peroxid treatment lipid.peroxid treat
31.06% rat antioxid induc level glutathion diabet lipid liver anim administr peroxid treatment bodi lipid.peroxid treat

Cluster Metrics

Authors
varalakshmi, p 13; menon, vp 10; subramanian, s 9; singh, s 9; sharma, s 9; kumar, r 9; panneerselvam, c 8; kumar, a 8; sharma, rk 7; prakash, bs 7; kumar, p 7; kulkarni, sk 7; chopra, k 7; swarup, d 6; sultana, s 6; srivastava, ak 6; rukkumani, r 6; pillai, kk 6; mythili, y 6; kumar, s 6

Sources
molecular and cellular biochemistry 36; indian journal of animal sciences 20; phytotherapy research 18; journal of ethnopharmacology 13; indian veterinary journal 13; toxicology 11; life sciences 11; journal of environmental biology 11; environmental toxicology and pharmacology 11; journal of medicinal food 10; phytomedicine 9; human & experimental toxicology 8; pharmaceutical biology 7; journal of pharmacy and pharmacology 7; clinica chimica acta 7; biological & pharmaceutical bulletin 7; toxicology mechanisms and methods 6; pharmazie 6; pharmacology biochemistry and behavior 6; pharmacological reports 6

Keywords
pharmacology & pharmacy 96; pharmacology & pharmacy 94; oxidative stress 80; chemistry, medicinal 74; glutathione 61; toxicology 60; rats 58; lipid-peroxidation 58; biochemistry & molecular biology 57; liver 50; lipid peroxidation 50; lipid-peroxidation 48; acid 42; cell biology 41; mice 41; environmental sciences 40; toxicity 37; superoxide-dismutase 36; assay 34; rat 32

Publication Year
2005 637; 2006 12; 2004 2

Country

india 651; usa 31; japan 7; canada 6; germany 5; peoples r china 4; kuwait 4; south korea 3; hungary 3; france 3; england 3; u arab emirates 1; taiwan 1; switzerland 1; slovakia 1; netherlands 1; malaysia 1; jordan 1; italy 1; ireland 1

Institution
univ madras 67; annamalai univ 38; indian vet res inst 22; cent food technol res inst 17; cent drug res inst 17; panjab univ 16; bhabha atom res ctr 16; all india inst med sci 16; kasturba med coll & hosp 14; jadavpur univ 13; ind toxicol res ctr 13; univ rajasthan 12; natl dairy res inst 12; indian inst chem biol 11; univ delhi 10; punjab agr univ 10; postgrad inst med educ & res 10; maharaja sayajirao univ baroda 10; jawaharlal nehru univ 10; banaras hindu univ 10

DataBase
science citation index 651

Citations
lowry oh, 1951, j biol chem, v193, p265 154; ohkawa h, 1979, anal biochem, v95, p351 55; rotruck jt, 1973, science, v179, p588 52; habig wh, 1974, j biol chem, v249, p7130 52; ellman gl, 1959, arch biochem biophys, v82, p70 37; sinha ak, 1972, anal biochem, v47, p389 34; moron ms, 1979, biochim biophys acta, v582, p67 33; marklund s, 1974, eur j biochem, v47, p469 33; kakkar p, 1984, indian j biochem bio, v21, p130 30; reitman s, 1957, am j clin pathol, v28, p56 23; folch j, 1957, j biol chem, v226, p497 21; misra hp, 1972, j biol chem, v247, p3170 19; jollow dj, 1974, pharmacology, v11, p151 19; aebi h, 1984, method enzymol, v105, p121 19; lowry oh, 1951, j biol chem, v193, p275 16; desai id, 1984, method enzymol, v105, p138 16; sedlak j, 1968, anal biochem, v25, p192 15; laemmli uk, 1970, nature, v227, p680 15; jiang zy, 1992, anal biochem, v202, p384 15; fiske ch, 1925, j biol chem, v66, p375 15

CLUSTER 7

- **CELL BIOLOGY/ GENETICS**

(1168 Records)

Cluster Syntax Features

Descriptive Terms
cell 11.2%, protein 8.8%, activ 4.8%, gene 4.0%, express 3.5%, dna 1.9%, enzym 1.8%, strain 1.5%, inhibit 1.4%, sequenc 1.3%, isol 1.2%, bind 0.9%, compound 0.8%, human 0.7%, induc 0.7%, vitro 0.7%, transcript 0.6%, immun 0.5%, kda 0.5%, acid 0.5%

Discriminating Terms
cell 8.4%, protein 6.7%, gene 3.0%, express 2.6%, activ 2.0%, dna 1.2%, enzym 1.2%, temperatur 0.9%, inhibit 0.9%, strain 0.8%, sequenc 0.7%, model 0.6%, patient 0.5%, film 0.5%, transcript 0.5%, phase 0.5%, isol 0.5%, kda 0.5%, bind 0.5%, paramet 0.5%

Single Word Terms
activ 546, cell 499, protein 486, express 321, gene 281, inhibit 248, two 247, level 246, acid 239, role 238, induc 231, isol 210, sequenc 207, function 203, human 201, enzym 199, vitro 196, high 187, on 185, dna 185

Double Word Terms
amino.acid 107, escherichia.coli 91, cell.line 70, molecular.weight 57, plai.role 57, gene.express 56, sd.page 54, mycobacterium.tuberculosi 52, western.blot 46, immun.respons 46, wild.type 41, enzym.activ 40, first.time 39, cancer.cell 35, depend.manner 35, molecular.mass 35, protein.kinas 33, transcript.factor 32, dose.depend 31, activ.enzym 30

Triple Word Terms
polymeras.chain.reaction 28, amino.acid.sequenc 24, cancer.cell.line 22, open.read.frame 21, chain.reaction.pcr 20, amino.acid.residu 18, reactiv.oxygen.speci 18, dose.depend.manner 17, express.escherichia.coli 16, activ.protein.kinas 15, low.molecular.weight 15, molecular.mass.kda 14, link.immunosorb.assai 14, molecular.weight.kda 14, enzym.link.immunosorb 14, mitogen.activ.protein 12, gel.filtrat.chromatographi 12, gram.posit.gram 11, polyacrylamid.gel.electrophoresi 11, posit.gram.neg 11

Term Cliques
15.84% sequenc isol human kda
16.22% strain sequenc isol kda acid
17.89% enzym inhibit compound acid
16.20% enzym strain compound acid
16.08% enzym strain isol kda acid
15.78% dna bind human induc vitro immun
15.70% dna strain vitro
18.56% gene dna sequenc isol human

18.42% gene dna strain sequenc isol acid
19.43% activ bind human induc vitro immun kda
24.40% activ inhibit compound vitro
21.12% activ inhibit bind human induc vitro kda
22.11% activ strain vitro kda
22.71% activ strain compound vitro
24.46% activ enzym inhibit compound
22.17% activ enzym strain kda
22.77% activ enzym strain compound
21.08% protein enzym inhibit bind kda acid
22.23% protein express sequenc bind kda acid
21.69% protein express sequenc bind human kda
22.82% protein express inhibit bind kda acid
22.76% protein express inhibit bind transcript acid
21.00% protein express dna bind human induc immun
21.47% protein gene express dna bind human induc transcript
21.62% protein gene express dna sequenc bind transcript acid
21.21% protein gene express dna sequenc bind human transcript
25.46% protein activ enzym inhibit bind kda
23.54% protein activ express bind human induc immun kda
25.02% protein activ express inhibit bind human induc kda
24.98% protein activ express inhibit bind human induc transcript
20.29% cell dna human induc vitro immun
25.44% cell activ human induc vitro immun
27.41% cell activ inhibit human induc vitro
24.87% cell protein express dna human induc immun
24.96% cell protein express dna human induc transcript
29.28% cell protein activ express human induc immun
28.36% cell protein activ express inhibit human induc transcript

Cluster Metrics

Authors
das, s 17; gupta, s 16; sinha, s 14; kumar, a 14; singh, s 13; singh, r 13; sharma, s 13; kumar, s 13; sharma, a 11; puri, sk 11; kumar, r 11; gupta, sk 11; tyagi, ak 10; pandey, a 10; srivastava, k 9; singh, j 9; singh, a 9; prasad, r 9; gupta, a 9; yogeeswari, p 8

Sources
biochemical and biophysical research communications 43; bioorganic & medicinal chemistry letters 32; current science 29; molecular and cellular biochemistry 24; nucleic acids research 19; journal of biological chemistry 19; world journal of microbiology & biotechnology 17; indian journal of animal sciences 16; bioorganic & medicinal chemistry 14; indian journal of biochemistry & biophysics 12; febs letters 12; indian veterinary journal 11; asian journal of chemistry 11; international journal of systematic and evolutionary microbiology 10; european journal of medicinal chemistry 10;

biochemical journal 10; plant science 9; enzyme and microbial technology 9; medicinal chemistry research 8; journal of immunology 8

Keywords
biochemistry & molecular biology 284; biophysics 103; biotechnology & applied microbiology 92; expression 92; chemistry, medicinal 82; proteins 63; immunology 62; microbiology 58; cells 58; identification 55; protein 53; purification 52; chemistry, organic 50; in-vitro 48; gene 48; binding 48; cell biology 47; escherichia-coli 47; microbiology 46; sequence 44

Publication Year
2005 1119; 2006 29; 2004 20

Country
india 1168; usa 98; germany 39; japan 27; england 22; south korea 9; france 9; italy 8; peoples r china 7; hungary 7; australia 7; switzerland 5; sweden 5; taiwan 4; spain 4; iran 4; canada 4; brazil 4; south africa 3; singapore 3

Institution
indian inst sci 58; cent drug res inst 45; indian inst technol 42; univ delhi 39; jawaharlal nehru univ 38; ctr cellular & mol biol 37; bose inst 30; all india inst med sci 25; natl inst immunol 24; indian inst chem biol 23; indian agr res inst 23; tata inst fundamental res 22; int ctr genet engn & biotechnol 21; indian vet res inst 21; bhabha atom res ctr 21; banaras hindu univ 20; aligarh muslim univ 20; postgrad inst med educ & res 19; univ hyderabad 18; inst microbial technol 18

DataBase
science citation index 1168

Citations
laemmli uk, 1970, nature, v227, p680 115; lowry oh, 1951, j biol chem, v193, p265 95; sambrook j, 1989, mol cloning lab manu 80; bradford mm, 1976, anal biochem, v72, p248 58; altschul sf, 1997, nucleic acids res, v25, p3389 43; towbin h, 1979, p natl acad sci usa, v76, p4350 32; thompson jd, 1994, nucleic acids res, v22, p4673 30; murashige t, 1962, physiol plantarum, v15, p473 23; altschul sf, 1990, j mol biol, v215, p403 21; sambrook j, 2001, mol cloning lab manu 18; cole st, 1998, nature, v393, p537 18; mosmann t, 1983, j immunol methods, v65, p55 16; thompson jd, 1997, nucleic acids res, v25, p4876 14; lambros c, 1979, j parasitol, v65, p418 14; trager w, 1976, science, v193, p673 13; smith pk, 1985, anal biochem, v150, p76 12; lowry oh, 1951, j biol chem, v193, p275 12; kimura m, 1980, j mol evol, v16, p111 12; dubois m, 1956, anal chem, v28, p350 12; chomczynski p, 1987, anal biochem, v162, p156 12

CLUSTER 5

- **HUMAN PATIENT DISEASES**

(1218 Records)

Cluster Syntax Features

Descriptive Terms
patient 30.4%, diseas 1.9%, infect 1.7%, clinic 1.6%, women 1.3%, children 1.3%, ag 1.2%, diagnosi 1.0%, hiv 1.0%, treatment 0.9%, surgeri 0.8%, case 0.8%, therapi 0.7%, risk 0.6%, lesion 0.6%, test 0.6%, control 0.6%, mean 0.6%, ey 0.6%, complic 0.5%

Discriminating Terms
patient 21.7%, diseas 1.1%, clinic 1.1%, temperatur 0.9%, women 0.9%, children 0.9%, infect 0.9%, model 0.8%, diagnosi 0.7%, hiv 0.7%, complex 0.6%, ag 0.6%, acid 0.6%, structur 0.6%, surgeri 0.6%, compound 0.5%, activ 0.5%, reaction 0.5%, therapi 0.5%, ion 0.4%

Single Word Terms
patient 736, on 327, clinic 316, two 313, ag 312, diseas 304, treatment 267, background 254, control 242, case 240, mean 230, infect 222, high 211, posit 208, diagnosi 201, total 196, rate 187, three 182, test 177, factor 171

Double Word Terms
mean.ag 57, patient.patient 55, two.patient 50, on.patient 48, risk.factor 48, three.patient 42, four.patient 39, hiv.infect 37, male.femal 36, magnet.reson 36, on.hundr 34, odd.ratio 34, confid.interv 33, patient.control 33, patient.mean 31, ag.sex 31, logist.regress 30, reson.imag 28, patient.on 27, tertiari.care 27

Triple Word Terms
magnet.reson.imag 28, polymeras.chain.reaction 21, bodi.mass.index 20, human.immunodefici.viru 19, ratio.confid.interv 17, odd.ratio.confid 16, fine.needl.aspir 16, central.nervou.system 16, ag.sex.match 16, immunodefici.viru.hiv 14, mass.index.bmi 14, squamou.cell.carcinoma 14, sex.match.control 13, world.health.organ 13, correct.visual.acuiti 13, acid.fast.bacilli 13, diseas.free.surviv 13, enzym.link.immunosorb 12, link.immunosorb.assai 12, reson.imag.mri 11

Term Cliques
14.32% treatment case therapi lesion complic
13.86% treatment surgeri case ey complic
15.09% treatment surgeri case therapi complic
15.97% diagnosi treatment case ey
15.44% diagnosi treatment case therapi lesion
15.73% women ag risk mean complic
14.33% women ag therapi risk complic
12.86% infect women therapi risk complic
18.59% diseas children ag risk mean
17.72% diseas children ag risk test
18.76% diseas women ag risk control mean
17.16% diseas women ag therapi risk test control

21.22% diseas clinic children ag mean
19.70% diseas clinic children ag diagnosi test
16.24% diseas infect hiv treatment therapi risk test control
16.24% diseas infect children risk test
14.80% diseas infect women hiv therapi risk test control
17.88% diseas infect clinic hiv treatment therapi test control
18.47% diseas infect clinic children diagnosi test
23.86% patient treatment lesion mean complic
22.46% patient treatment therapi lesion complic
22.33% patient ag treatment risk mean ey complic
23.93% patient ag treatment therapi risk complic
22.07% patient ag treatment surgeri mean ey complic
26.29% patient ag treatment surgeri control mean
23.63% patient ag treatment surgeri therapi complic
25.12% patient ag treatment surgeri therapi control
26.04% patient ag diagnosi treatment ey
27.29% patient clinic ag treatment mean complic
26.12% patient clinic ag treatment therapi complic
22.70% patient infect treatment therapi risk complic
24.89% patient infect clinic treatment therapi complic
26.67% patient diseas treatment lesion mean
23.81% patient diseas diagnosi treatment therapi lesion
26.35% patient diseas ag treatment risk control mean
24.00% patient diseas ag treatment therapi risk test control
28.23% patient diseas clinic ag treatment control mean
25.65% patient diseas clinic ag treatment therapi test control
25.23% patient diseas clinic ag diagnosi treatment therapi test
23.08% patient diseas infect treatment therapi risk test control
24.72% patient diseas infect clinic treatment therapi test control
24.30% patient diseas infect clinic diagnosi treatment therapi test

Cluster Metrics

Authors
kumar, a 29; srivastava, a 24; singh, r 22; kumar, r 22; kumar, s 20; sharma, a 18; gupta, ak 17; gupta, v 16; gupta, s 14; singh, s 13; singh, n 13; sharma, n 12; gupta, rk 12; saxena, r 11; purkayastha, s 11; bhattacharya, sk 11; agarwal, a 11; pandey, rm 10; mahapatra, ak 10; gupta, a 10

Sources
indian journal of medical research 34; indian veterinary journal 22; national medical journal of india 17; neurology india 14; journal of clinical neuroscience 12; journal of tropical pediatrics 11; anesthesia and analgesia 11; acta cytologica 11; surgical laparoscopy endoscopy & percutaneous techniques 10; pediatric surgery international 10; pediatric neurosurgery 10; journal of endourology 10; journal of clinical microbiology

10; annals of thoracic surgery 10; rivista di neuroradiologia 9; journal of laryngology and otology 9; international journal of dermatology 9; american journal of ophthalmology 9; tropical medicine & international health 8; medicine science and the law 8

Keywords
surgery 146; india 94; clinical neurology 82; ophthalmology 76; public, environmental & occupational health 71; occupational health 71; public, environmental & 71; medicine, general & internal 70; immunology 61; children 53; surgery 52; diagnosis 52; radiology, nuclear medicine & medical imaging 49; pediatrics 49; pediatrics 49; prevalence 47; tropical medicine 46; cardiac & cardiovascular systems 41; urology & nephrology 40; hematology 40

Publication Year
2005 1176; 2006 21; 2004 21

Country
india 1218; usa 129; england 67; canada 23; france 20; germany 18; australia 17; italy 16; japan 14; switzerland 13; peoples r china 12; sweden 10; spain 10; netherlands 10; brazil 9; thailand 8; singapore 8; argentina 7; vietnam 6; south korea 6

Institution
all india inst med sci 170; postgrad inst med educ & res 82; christian med coll & hosp 66; sanjay gandhi postgrad inst med sci 65; tata mem hosp 29; sree chitra tirunal inst med sci & technol 29; univ delhi 20; natl inst mental hlth & neurosci 20; king georges med univ 20; maulana azad med coll 19; lv prasad eye inst 16; kasturba med coll & hosp 16; univ coll med sci 15; indian council med res 15; safdarjang hosp 13; who 12; natl inst cholera & enter dis 12; icmr 12; univ calif san francisco 10; king edward mem hosp 10

DataBase
science citation index 1218

Citations
wild s, 2004, diabetes care, v27, p1047 10; miller sa, 1988, nucleic acids res, v16, p1215 9; ramachandran a, 2001, diabetologia, v44, p1094 8; matthews dr, 1985, diabetologia, v28, p412 8; friedewald wt, 1972, clin chem, v18, p499 8; gavin jr, 1997, diabetes care, v20, p1183 6; deepa m, 2003, j assoc physician i, v51, p863 6; rodeghiero f, 1987, blood, v69, p454 5; mohan v, 2001, j am coll cardiol, v38, p682 5; khatri gr, 2002, new engl j med, v347, p1420 5; kaplan el, 1958, j am stat assoc, v53, p457 5; jacob a, 1998, ind j ophthalmol, v46, p81 5; eisenach kd, 1990, j infect dis, v161, p977 5; cleeman ji, 2001, jama-j am med assoc, v285, p2486 5; chandalia m, 1999, j clin endocr metab, v84, p2329 5; black hr, 1997, arch intern med, v157, p2413 5; bhave g, 1995, aids s1, v9, s21 5; banerji ma, 1999, j clin endocr metab, v84, p137 5; alberti kgmm, 1998, diabetic med, v15, p539 5; *who, 2001, world hlth rep 2001 5

CLUSTER 15

- **SOIL/ CROP EXPERIMENTS**

(952 Records)

Cluster Syntax Features

Descriptive Terms
speci 6.5%, soil 4.7%, crop 2.6%, popul 2.4%, indian 1.7%, genet 1.7%, polymorph 1.5%, gene 1.4%, rice 1.3%, yield 1.0%, season 0.9%, area 0.9%, divers 0.8%, forest 0.8%, wheat 0.8%, plant 0.7%, trait 0.7%, pcr 0.7%, famili 0.7%, water 0.7%

Discriminating Terms
speci 4.7%, soil 3.5%, crop 2.2%, popul 1.8%, genet 1.3%, polymorph 1.3%, indian 1.1%, rice 0.9%, temperatur 0.9%, acid 0.8%, model 0.7%, forest 0.7%, season 0.7%, compound 0.7%, divers 0.6%, trait 0.6%, gene 0.6%, complex 0.6%, activ 0.6%, structur 0.6%

Single Word Terms
speci 238, two 234, level 199, high 198, popul 198, on 185, indian 185, area 176, product 169, total 162, region 161, genet 161, three 158, conduct 149, field 147, system 144, data 140, crop 139, sampl 137, yield 137

Double Word Terms
experi.conduct 68, field.experi 59, chain.reaction 42, polymeras.chain 41, grain.yield 40, sampl.collect 40, west.bengal 37, winter.season 33, crop.system 33, genet.divers 32, wheat.triticum 31, new.speci 29, rice.oryza 27, oryza.sativa 27, triticum.aestivum 26, raini.season 26, length.polymorph 25, first.time 24, polymorph.dna 24, fragment.length 24

Triple Word Terms
field.experi.conduct 45, polymeras.chain.reaction 41, wheat.triticum.aestivum 26, rice.oryza.sativa 26, fragment.length.polymorph 23, amplifi.polymorph.dna 22, chain.reaction.pcr 21, polymorph.dna.rapd 17, emend.fiori.paol 16, restrict.fragment.length 16, triticum.aestivum.emend 16, random.amplifi.polymorph 15, aestivum.emend.fiori 13, maiz.zea.mai 11, mustard.brassica.juncea 10, clai.loam.soil 10, experi.conduct.winter 9, sequenc.repeat.ssr 9, singl.nucleotid.polymorph 9, indian.mustard.brassica 8

Term Cliques
8.64% gene rice wheat trait
11.34% genet divers plant trait famili
11.27% genet rice plant trait
11.16% genet gene rice trait
13.13% popul area divers forest famili
12.71% popul genet polymorph gene divers trait famili
15.71% popul indian area divers famili

13.87% popul indian genet polymorph gene divers pcr famili
10.66% crop rice yield wheat plant trait
13.30% soil season area forest plant
14.56% soil crop yield season area plant water
12.30% soil crop rice yield season wheat plant water
13.31% speci divers pcr famili
13.99% speci area divers forest plant famili
16.74% speci season area plant water
15.46% speci season area forest plant

Cluster Metrics

Authors
kumar, s 15; kumar, a 13; bhattacharya, sk 12; singh, s 10; sharma, a 10; karunasagar, i 10; singh, r 8; sharma, r 8; sharma, s 7; kumar, n 7; sukumar, r 6; singh, rk 6; sharma, p 6; mohanty, d 6; kumar, r 6; kumar, d 6; khan, ml 6; gupta, ak 6; das, dk 6; upadhyaya, hd 5

Sources
current science 70; indian journal of agronomy 39; indian veterinary journal 35; indian journal of agricultural sciences 27; indian journal of animal sciences 24; euphytica 14; journal of the geological society of india 12; journal of environmental biology 11; environmental monitoring and assessment 9; asian-australasian journal of animal sciences 8; asian journal of chemistry 8; oriental insects 7; journal of sustainable agriculture 7; journal of human genetics 7; genetic resources and crop evolution 7; crop science 7; theoretical and applied genetics 6; revue scientifique et technique-office international des epizooties 6; plant breeding 6; journal of tropical forest science 6

Keywords
agronomy 111; india 80; multidisciplinary sciences 75; veterinary sciences 50; agriculture, dairy & animal science 45; plant sciences 45; environmental sciences 43; agriculture, multidisciplinary 42; environmental sciences 42; plant sciences 32; diversity 31; growth 30; genetics & heredity 29; yield 29; public, environmental & occupational health 26; occupational health 26; public, environmental & 26; geosciences, multidisciplinary 25; entomology 24; dna 24

Publication Year
2005 904; 2004 38; 2006 9; 2002 1

Country
india 952; usa 63; england 26; australia 25; germany 20; peoples r china 19; japan 16; france 12; south korea 8; scotland 8; netherlands 8; switzerland 7; sweden 7; spain 7; italy 7; canada 7; mexico 6; thailand 5; brazil 5; belgium 5

Institution
indian agr res inst 32; indian inst technol 30; indian inst sci 25; int crops res inst semi arid trop 18; indian vet res inst 18; all india inst med sci 18; univ delhi 17; punjab agr univ 16;

natl inst oceanog 15; jawaharlal nehru univ 15; indian stat inst 15; banaras hindu univ 14; indian council med res 13; wildlife inst india 12; bidhan chandra krishi viswavidyalaya 11; univ lucknow 10; univ calcutta 10; agharkar res inst 10; natl inst cholera & enter dis 9; univ agr sci 8

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science citation index 952

Citations
sambrook j, 1989, mol cloning lab manu 23; williams jgk, 1990, nucleic acids res, v18, p6531 16; jackson ml, 1973, soil chem anal 14; miller sa, 1988, nucleic acids res, v16, p1215 13; walkley a, 1934, soil sci, v37, p29 12; sneath pha, 1973, numerical taxonomy 12; vos p, 1995, nucleic acids res, v23, p4407 10; nei m, 1973, p national academy s, v70, p3321 10; subbiah bv, 1956, curr sci, v25, p259 9; gomez ka, 1984, stat procedures agr 9; myers n, 2000, nature, v403, p853 8; mantel n, 1967, cancer res, v27, p209 8; doyle jj, 1990, focus, v12, p13 8; welsh j, 1990, nucleic acids res, v18, p7213 7; weir bs, 1984, evolution, v38, p1358 7; simpson eh, 1949, nature, v163, p688 7; prevost a, 1999, theor appl genet, v98, p107 7; olsen sr, 1954, 939 usda 7; nei m, 1978, genetics, v89, p583 7; lindsay wl, 1978, soil sci soc am j, v42, p421 7

CLUSTER 12

- **GEOLOGICAL RESEARCH/ MATERIAL MECHANICS**

(717 Records)

Cluster Syntax Features

Descriptive Terms
sediment 2.2%, weld 2.1%, monsoon 1.9%, model 1.8%, crack 1.7%, water 1.6%, rock 1.3%, sea 1.3%, region 1.2%, river 1.1%, basin 1.0%, load 1.0%, surfac 1.0%, depth 0.9%, zone 0.9%, area 0.9%, steel 0.8%, stress 0.8%, fault 0.8%, aerosol 0.8%

Discriminating Terms
sediment 2.2%, weld 2.1%, monsoon 1.8%, crack 1.7%, rock 1.3%, sea 1.2%, basin 1.1%, river 1.0%, acid 0.9%, patient 0.9%, aerosol 0.8%, compound 0.8%, depth 0.7%, ocean 0.7%, reaction 0.7%, fault 0.7%, zone 0.7%, seismic 0.7%, groundwat 0.7%, fatigu 0.7%

Single Word Terms
high 204, model 201, data 197, region 174, water 164, two 156, surfac 152, paramet 143, low 142, condit 136, rate 136, paper 134, area 134, temperatur 129, time 128, carri 122, level 115, indian 112, gener 109, on 107

Double Word Terms
arabian.sea 40, indian.ocean 29, bai.bengal 27, summer.monsoon 25, monsoon.season 24, surfac.temperatur 22, sea.surfac 22, stainless.steel 22, strain.rate 21, flow.rate 20, mathemat.model 19, finit.element 19, larg.scale 19, power.plant 19, test.conduct 17, stress.strain 16, experi.conduct 16, correl.coeffici 16, river.basin 15, sea.level 15

Triple Word Terms
sea.surfac.temperatur 17, aerosol.optic.depth 12, surfac.temperatur.sst 11, indian.summer.monsoon 11, austenit.stainless.steel 10, optic.depth.aod 8, arabian.sea.bai 8, low.cycl.fatigu 8, equatori.indian.ocean 7, remot.sens.satellit 7, sea.bai.bengal 7, summer.monsoon.rainfal 7, total.dissolv.solid 7, thermal.power.plant 7, arabian.sea.monsoon 6, eastern.arabian.sea 6, finit.element.model 6, major.trace.element 5, particl.size.distribut 5, rare.earth.element 5

Term Cliques
12.90% load surfac depth aerosol
14.69% region river basin surfac area fault
17.68% water load surfac depth
16.53% water river load surfac
15.17% model zone stress fault
17.20% model region depth zone area fault
18.46% model region surfac depth area fault
14.81% model crack load steel stress
16.43% model crack load surfac steel

16.76% model crack load surfac depth
14.04% monsoon sea region surfac depth aerosol
18.53% monsoon water region surfac depth area
16.66% monsoon water region river basin surfac area
17.22% monsoon water sea region surfac depth
15.54% monsoon water sea region river basin surfac
10.60% weld zone stress
14.32% weld region zone
10.21% weld crack load steel stress
14.03% sediment rock region depth zone area fault
12.95% sediment rock region river basin zone area fault
16.09% sediment water sea region depth zone
14.56% sediment water sea region river basin zone
16.46% sediment water rock region depth zone area
15.08% sediment water rock region river basin zone area
17.02% sediment monsoon water region depth area
15.36% sediment monsoon water region river basin area
15.71% sediment monsoon water sea region depth
14.25% sediment monsoon water sea region river basin

Cluster Metrics

Authors
mannan, sl 15; rao, kbs 10; singh, s 8; raj, b 8; kumar, s 8; rao, kp 7; singh, vs 6; ramesh, r 6; ghosh, s 6; ghosh, ak 6; dey, s 6; das, s 6; valsan, m 5; sinha, r 5; singh, r 5; shankar, r 5; saha, a 5; murthy, dsr 5; mondal, nc 5; latha, km 5

Sources
journal of the geological society of india 59; current science 44; transactions of the indian institute of metals 34; geophysical research letters 22; journal of earth system science 21; environmental monitoring and assessment 13; environmental geology 13; materials science and technology 12; atmospheric environment 12; journal of asian earth sciences 11; deep-sea research part ii-topical studies in oceanography 11; materials science and engineering a-structural materials properties microstructure and processing 10; international journal of remote sensing 10; journal of materials processing technology 8; indian journal of marine sciences 8; earth and planetary science letters 7; pure and applied geophysics 6; journal of geophysical research-atmospheres 6; journal of food engineering 6; geomorphology 5

Keywords
geosciences, multidisciplinary 135; materials science, multidisciplinary 65; india 55; multidisciplinary sciences 49; metallurgy & metallurgical engineering 49; environmental sciences 40; geochemistry & geophysics 33; water resources 31; engineering, civil 28; model 27; evolution 27; oceanography 26; engineering 25; metallurgy & metallurgical 25; engineering, chemical 24; behavior 24; engineering, mechanical 23; environmental sciences 23; remote sensing 21; basin 20

Publication Year
2005 694; 2006 19; 2004 4

Country
india 717; usa 46; germany 24; japan 18; england 15; canada 10; france 6; peoples r china 5; australia 5; italy 4; austria 4; thailand 3; south korea 3; south africa 2; singapore 2; russia 2; nepal 2; ireland 2; iran 2; finland 2

Institution
indian inst technol 133; natl geophys res inst 45; natl inst oceanog 36; indira gandhi ctr atom res 32; indian inst sci 31; bhabha atom res ctr 28; phys res lab 20; natl inst technol 15; geol survey india 14; anna univ 14; indian inst trop meteorol 13; vikram sarabhai space ctr 12; jadavpur univ 12; isro 10; wadia inst himalayan geol 9; univ delhi 9; univ calcutta 9; natl remote sensing agcy 9; natl inst hydrol 9; struct engn res ctr 8

DataBase
science citation index 717

Citations
kalnay e, 1996, b am meteorol soc, v77, p437 13; thamban m, 2001, palaeogeogr palaeocl, v165, p113 9; shankar d, 2002, prog oceanogr, v52, p63 8; mccreary jp, 1993, prog oceanogr, v31, p181 8; madhupratap m, 1996, nature, v384, p549 7; houghton jt, 2001, climate change 2001 7; haake b, 1993, deep-sea res pt i, v40, p1323 7; valdiya ks, 1980, geology kumaun lesse 6; stuiver m, 1998, radiocarbon, v40, p1041 6; sirocko f, 1993, nature, v364, p322 6; shenoi ssc, 1999, j geophys res-oceans, v104, p15703 6; satheesh sk, 2000, nature, v405, p60 6; sarin mm, 1989, geochim cosmochim ac, v53, p997 6; rao rr, 1999, q j roy meteor soc a, v125, p787 6; ramanathan v, 2001, j geophys res-atmos, v106, p28371 6; nair rr, 1989, nature, v338, p749 6; galy a, 1999, chem geol, v159, p31 6; curray jr, 1982, ocean basin margin, v6, p399 6; charlson rj, 1992, science, v255, p423 6; babu ss, 2002, geophys res lett, v29 6

CLUSTER 14
- **ALGORITHMS/ NETWORK MODELING**

(1372 Records)

Cluster Syntax Features

Descriptive Terms
algorithm 6.3%, model 5.9%, network 3.4%, system 3.3%, paper 3.2%, optim 2.2%, design 1.8%, simul 1.7%, oper 1.4%, set 1.4%, control 1.1%, time 1.1%, data 0.9%, comput 0.9%, power 0.9%, gener 0.8%, fuzzi 0.8%, paramet 0.8%, neural 0.7%, filter 0.7%

Discriminating Terms
algorithm 6.1%, network 3.0%, model 2.9%, paper 2.1%, optim 1.7%, design 1.3%, system 1.3%, simul 1.2%, acid 1.1%, patient 0.9%, oper 0.9%, set 0.8%, fuzzi 0.8%, temperatur 0.8%, reaction 0.8%, activ 0.7%, compound 0.7%, neural 0.7%, neural.network 0.7%, filter 0.7%

Single Word Terms
paper 644, model 482, system 465, time 345, two 333, algorithm 314, simul 306, data 298, gener 284, design 269, set 268, paramet 266, oper 256, optim 256, on 255, function 238, control 225, comput 223, applic 218, new 217

Double Word Terms
neural.network 104, genet.algorithm 67, artifici.neural 49, data.set 42, real.time 42, non.linear 41, model.model 35, network.model 35, paper.new 33, steadi.state 31, mathemat.model 31, two.dimension 28, network.ann 28, paper.deal 25, experiment.data 25, finit.element 25, input.output 23, simul.model 22, mean.squar 22, simul.anneal 22

Triple Word Terms
artifici.neural.network 48, neural.network.ann 28, neural.network.model 27, signal.nois.ratio 14, mean.squar.error 14, mont.carlo.simul 11, neural.network.train 10, sort.genet.algorithm 10, root.mean.squar 9, particl.swarm.optim 9, propag.neural.network 8, plai.vital.role 8, model.experiment.data 8, support.vector.machin 8, genet.algorithm.nsga 8, simul.anneal.algorithm 7, algorithm.simul.anneal 7, back.propag.neural 7, non.domin.sort 7, feed.forward.back 7

Term Cliques
17.13% design simul oper time comput power filter
17.15% design simul oper control time power filter
21.10% paper oper comput gener fuzzi paramet
21.12% paper oper control gener fuzzi paramet
22.34% paper design simul oper control time power gener paramet
21.96% paper optim design simul oper time comput power gener paramet
23.52% system paper oper comput gener fuzzi
23.54% system paper oper control gener fuzzi

23.96% system paper design simul oper control time power gener
23.41% system paper optim design simul oper time comput power gener
18.78% network paper set control gener fuzzi paramet neural
21.34% network paper set control time gener paramet neural
21.68% network paper simul control time gener paramet neural
20.59% network system paper set control gener fuzzi neural
23.15% network system paper set control time gener neural
23.50% network system paper simul control time gener neural
22.67% model design simul control time gener paramet
22.15% model optim design simul time comput gener paramet
24.74% model system design simul control time gener
23.96% model system optim design simul time comput gener
17.30% model network set control gener fuzzi paramet neural
19.86% model network set control time gener paramet neural
20.21% model network simul control time gener paramet neural
19.11% model network system set control gener fuzzi neural
21.67% model network system set control time gener neural
22.02% model network system simul control time gener neural
23.69% algorithm paper optim set time comput gener paramet
24.03% algorithm paper optim simul time comput gener paramet
25.50% algorithm system paper optim set time comput gener
25.85% algorithm system paper optim simul time comput gener
19.22% algorithm network paper set comput gener fuzzi paramet neural
21.49% algorithm network paper set time comput gener paramet neural
21.80% algorithm network paper simul time comput gener paramet neural
20.83% algorithm network system paper set comput gener fuzzi neural
23.10% algorithm network system paper set time comput gener neural
23.41% algorithm network system paper simul time comput gener neural
22.21% algorithm model optim set time comput gener paramet
22.56% algorithm model optim simul time comput gener paramet
24.03% algorithm model system optim set time comput gener
24.37% algorithm model system optim simul time comput gener
18.29% algorithm model network set data comput gener fuzzi paramet neural
20.34% algorithm model network set time data comput gener paramet neural
20.61% algorithm model network simul time data comput gener paramet neural
19.74% algorithm model network system set data comput gener fuzzi neural
21.79% algorithm model network system set time data comput gener neural
22.06% algorithm model network system simul time data comput gener neural

Cluster Metrics

Authors
kumar, r 19; kumar, s 18; kumar, a 14; singh, s 12; chaudhuri, s 9; tiwari, mk 8; singh, r 8; singh, b 8; shah, na 8; mukherjee, s 8; mitra, s 8; rao, vr 7; gupta, v 7; gupta, p 7; gupta, a 7; ghosh, a 7; chakraborty, s 7; sinha, s 6; sarkar, p 6; roy, s 6

Sources
iete journal of research 27; microwave and optical technology letters 19; journal of scientific & industrial research 18; international journal of advanced manufacturing technology 17; sadhana-academy proceedings in engineering sciences 14; journal of materials processing technology 13; indian journal of pure & applied physics 13; iete technical review 13; defence science journal 13; physical review e 10; international journal of production research 10; iee proceedings-electric power applications 10; electric power components and systems 10; materials and manufacturing processes 9; industrial & engineering chemistry research 9; communications in statistics-theory and methods 9; mathematical and computer modelling 8; journal of mathematical analysis and applications 8; indian journal of engineering and materials sciences 8; ieee transactions on power delivery 8

Keywords
engineering, electrical & electronic 224; telecommunications 67; mathematics, applied 64; computer science, artificial intelligence 59; design 52; engineering, chemical 51; engineering, industrial 48; model 46; computer science, interdisciplinary applications 44; automation & control systems 44; systems 42; engineering, mechanical 41; optimization 40; engineering, manufacturing 39; computer science, hardware & architecture 38; mathematics, applied 38; engineering, civil 37; optics 37; computer science, 37; statistics & probability 36

Publication Year
2005 1297; 2006 62; 2004 13

Country
india 1372; usa 124; peoples r china 33; england 24; canada 22; germany 18; france 18; south korea 15; singapore 14; japan 14; italy 13; australia 13; taiwan 8; netherlands 8; malaysia 7; sweden 6; spain 6; iran 5; saudi arabia 3; israel 3

Institution
indian inst technol 428; indian inst sci 103; indian stat inst 64; jadavpur univ 35; natl inst technol 31; ind technol inst 23; univ delhi 22; anna univ 22; tata inst fundamental res 18; banaras hindu univ 16; univ calcutta 15; indian inst management 13; iit 13; natl chem lab 12; psg coll technol 11; osmania univ 11; cochin univ sci & technol 11; bengal engn & sci univ 11; aligarh muslim univ 11; univ hyderabad 10

DataBase
science citation index 1372

Citations
goldberg de, 1989, genetic algorithms s 18; deb k, 2001, multiobjective optim 14; zadeh la, 1965, inform contr, v8, p338 12; holland jh, 1975, adaptation natural a 10; kennedy j, 1995, p ieee int c neur ne, v4, p1942 9; deb k, 2002, ieee t evolut comput, v6, p182 9; hornik k, 1989, neural networks, v2, p359 8; cybenko g, 1989, math control signal, v2, p303 8; coello cac, 2002, evolutionary algorit 8; deb k, 1995, optimization eng des 7;

daubechies i, 1992, 10 lect wavelets 7; *asce task comm ap, 2000, j hydrol eng, v5, p115 7; haykin s, 1994, neural networks comp 6; bishop cm, 1995, neural networks patt 6; bezdek jc, 1981, pattern recognition 6; srinivas n, 1995, evolutionary computa, v2, p221 5; rao ss, 1996, eng optimization the 5; randic m, 1975, j am chem soc, v97, p6609 5; press wh, 1992, numerical recipes fo 5; pawlak z, 1991, rough sets theoretic 5

CLUSTER 11

- **CONTINUUM ANALYSIS**

(1255 Records)

Cluster Syntax Features

Descriptive Terms
equat 5.2%, flow 3.5%, field 3.4%, wave 2.7%, veloc 1.9%, solut 1.8%, model 1.8%, numer 1.4%, fluid 1.3%, theori 1.2%, finit 1.1%, space 1.1%, dimension 1.0%, heat 0.9%, paramet 0.9%, pressur 0.8%, boundari 0.8%, magnet 0.8%, nonlinear 0.7%, function 0.7%

Discriminating Terms
equat 4.7%, flow 2.8%, wave 2.3%, field 2.2%, veloc 1.7%, numer 1.2%, fluid 1.2%, acid 1.1%, finit 1.0%, patient 1.0%, activ 1.0%, theori 0.9%, compound 0.8%, reaction 0.7%, dimension 0.7%, space 0.7%, solut 0.7%, boundari 0.7%, complex 0.7%, cell 0.6%

Single Word Terms
equat 421, model 353, two 349, field 323, solut 303, paramet 301, flow 260, numer 248, condit 229, function 224, paper 222, system 217, order 215, veloc 212, gener 207, theori 206, number 205, time 204, on 204, finit 203

Double Word Terms
magnet.field 85, finit.element 76, boundari.condit 69, two.dimension 69, differenti.equat 59, three.dimension 55, experiment.data 55, heat.transfer 48, reynold.number 48, on.dimension 44, close.form 36, power.law 35, binari.mixtur 35, black.hole 35, first.order 34, numer.solut 33, steadi.state 33, govern.equat 33, finit.differ 31, numer.simul 30

Triple Word Terms
order.shear.deform 17, shear.deform.theori 17, partial.differenti.equat 17, navier.stoke.equat 16, excess.molar.volum 15, close.form.solut 14, ordinari.differenti.equat 14, mass.transfer.coeffici 13, first.order.shear 13, heat.transfer.coeffici 13, finit.element.model 11, fit.redlich.kister 11, molecular.dynam.simul 10, uniform.magnet.field 10, flow.heat.transfer 10, low.reynold.number 9, finit.element.formul 9, mont.carlo.simul 9, satur.porou.medium 8, close.form.express 8

Term Cliques
16.75% field wave solut numer fluid theori finit paramet boundari magnet nonlinear
16.98% field wave veloc solut numer fluid finit heat paramet boundari magnet
17.59% flow field veloc solut numer fluid finit heat paramet boundari magnet
19.04% equat model numer fluid heat paramet pressur boundari function
19.65% equat model numer fluid theori paramet pressur boundari function
19.12% equat field wave solut numer theori finit space dimension paramet nonlinear function

18.66% equat field wave solut numer fluid theori finit dimension paramet boundari nonlinear function
20.73% equat field wave solut model numer theori finit space dimension paramet function
19.72% equat field wave solut model numer fluid finit dimension heat paramet boundari function
20.14% equat field wave solut model numer fluid theori finit dimension paramet boundari function
19.64% equat field wave veloc solut model numer fluid finit dimension heat paramet boundari
19.12% equat flow veloc model numer fluid heat paramet pressur boundari
20.16% equat flow field veloc solut model numer fluid finit dimension heat paramet boundari

Cluster Metrics

Authors
kumar, a 17; ghosh, s 14; chakraborty, s 13; kumar, s 11; kumar, r 11; sharma, a 8; sen, a 8; das, a 8; biswas, i 8; sunil 7; sengupta, s 7; sarkar, s 7; rahaman, f 7; kapoor, s 7; gopalakrishnan, s 7; chatterjee, a 7; sujith, ri 6; singh, r 6; singh, ak 6; rattan, vk 6

Sources
physical review e 26; physical review d 26; physics of plasmas 25; journal of high energy physics 24; international journal of heat and mass transfer 21; journal of sound and vibration 17; pramana-journal of physics 14; physical review letters 14; journal of physics a-mathematical and general 14; indian journal of pure & applied physics 14; indian journal of physics and proceedings of the indian association for the cultivation of science 14; asian journal of chemistry 14; physics of fluids 13; applied mathematics and computation 13; transactions of the indian institute of metals 12; physical review b 12; physica b-condensed matter 11; modern physics letters a 11; international journal of modern physics d 11; composite structures 11

Keywords
mechanics 122; physics, multidisciplinary 117; engineering, mechanical 97; mathematics, applied 94; physics, fluids & plasmas 89; thermodynamics 75; mathematics 64; model 59; physics, particles & fields 54; engineering, chemical 50; chemistry, physical 47; astronomy & astrophysics 46; physics, mathematical 45; mechanics 41; systems 41; flow 41; physics, condensed matter 37; chemistry, multidisciplinary 37; physics, mathematical 34; stability 33

Publication Year
2005 1190; 2006 45; 2004 20

Country

india 1255; usa 100; japan 31; germany 30; france 29; peoples r china 17; england 14; south korea 9; italy 8; canada 8; australia 8; switzerland 5; singapore 5; russia 5; kuwait 5; denmark 5; belgium 5; south africa 4; netherlands 4; iran 4

Institution
indian inst technol 311; indian inst sci 106; tata inst fundamental res 50; jadavpur univ 43; indian stat inst 33; univ delhi 24; natl inst technol 23; harish chandra res inst 22; banaras hindu univ 21; sn bose natl ctr basic sci 20; saha inst nucl phys 20; inst math sci 19; raman res inst 17; indian assoc cultivat sci 15; panjab univ 14; kurukshetra univ 14; inst phys 14; bhabha atom res ctr 13; aligarh muslim univ 13; anna univ 12

DataBase
science citation index 1255

Citations
patankar sv, 1980, numerical heat trans 19; redlich o, 1948, ind eng chem, v40, p345 18; seiberg n, 1999, j high energy phys 15; sen a, 2002, j high energy phys 13; maldacena j, 1998, adv theor math phys, v2, p231 10; degennes pg, 1993, phys liquid crystals 10; sen a, 2005, j high energy phys 9; randall l, 1999, phys rev lett, v83, p4690 9; douglas mr, 2001, rev mod phys, v73, p977 9; rao nn, 1990, planet space sci, v38, p543 8; finlayson ba, 1970, j fluid mech, v40, p753 8; witten e, 1998, adv theoret math phy, v2, p253 7; whitham gb, 1974, linear nonlinear wav 7; sen a, 1995, mod phys lett a, v10, p2081 7; schwab l, 1983, j magn magn mater, v39, p113 7; scanlon jw, 1973, phys fluids, v16, p1573 7; rosensweig re, 1985, ferrohydrodynamics 7; polchinski j, 1998, string theory, v1 7; perlmutter s, 1999, astrophys j 1, v517, p565 7; padmanabhan t, 2002, phys rev d, v66 7

CLUSTER 13

- **MOLECULAR LEVEL CALCULATIONS**

(1064 Records)

Cluster Syntax Features

Descriptive Terms
energi 4.6%, state 3.4%, electron 1.9%, calcul 1.7%, bar 1.6%, laser 1.5%, densiti 1.5%, model 1.4%, decai 1.3%, gamma 1.1%, excit 1.0%, spin 1.0%, quantum 0.9%, transit 0.9%, band 0.8%, scatter 0.8%, beam 0.8%, collis 0.8%, potenti 0.8%, mode 0.7%

Discriminating Terms
energi 3.1%, state 2.0%, bar 1.5%, calcul 1.4%, laser 1.3%, decai 1.2%, acid 1.1%, patient 1.0%, activ 0.9%, excit 0.9%, electron 0.8%, complex 0.8%, collis 0.8%, quantum 0.8%, densiti 0.8%, spin 0.7%, gamma 0.7%, detector 0.7%, scatter 0.7%, beam 0.7%

Single Word Terms
energi 386, state 304, model 299, two 280, electron 237, data 233, calcul 232, densiti 208, experiment 202, structur 192, function 191, measur 189, system 184, high 174, interact 173, paramet 171, on 156, order 155, transit 154, depend 153

Double Word Terms
cross.section 83, ground.state 54, densiti.function 50, experiment.data 39, excit.state 38, gamma.rai 35, densiti.state 34, function.theori 34, bell.detector 32, potenti.energi 32, vertic.bar 28, high.energi 27, phase.transit 27, detector.kekb 27, quantum.mechan 26, upper.limit 26, first.time 25, basi.set 25, gamma.gamma 25, electron.structur 25

Triple Word Terms
densiti.function.theori 33, bell.detector.kekb 27, differenti.cross.section 19, root.200.gev 16, fermilab.tevatron.collid 15, vertic.bar.vertic 15, bar.vertic.bar 14, reson.bell.detector 13, collect.bell.detector 13, collis.root.200 13, product.cross.section 13, local.densiti.approxim 12, detector.kekb.asymmetr 11, linear.augment.plane 10, augment.plane.wave 10, mont.carlo.simul 10, potenti.linear.augment 9, spin.orbit.interact 9, function.theori.dft 9, centr.mass.energi 9

Term Cliques
12.03% electron laser scatter beam
13.60% electron laser transit scatter
12.41% electron laser excit beam
13.98% electron laser excit transit
15.06% energi gamma beam collis
15.93% energi gamma excit beam
16.98% energi model gamma excit spin band
18.39% energi model decai excit transit mode
18.18% energi model decai gamma collis
18.87% energi model decai gamma excit

16.38% energi bar decai mode
14.25% energi bar decai gamma collis
17.64% energi calcul transit scatter potenti mode
18.26% energi calcul model excit transit band potenti mode
18.27% energi calcul model excit quantum transit potenti mode
16.64% energi electron scatter beam collis
19.36% energi electron excit beam
19.10% energi electron densiti scatter beam
19.36% energi electron calcul scatter collis
23.14% energi electron calcul model collis
19.66% energi electron calcul densiti transit scatter potenti
18.74% energi electron calcul densiti spin transit scatter
21.48% energi state model decai excit transit
20.76% energi state electron calcul model excit transit band potenti
20.77% energi state electron calcul model excit quantum transit potenti
20.05% energi state electron calcul model excit spin transit band
20.06% energi state electron calcul model excit spin quantum transit
21.74% energi state electron calcul densiti model transit band potenti
21.03% energi state electron calcul densiti model spin transit band

Cluster Metrics

Authors
abe, k 64; banerjee, s 56; li, j 52; zhang, zp 50; chen, a 42; kang, jh 41; villa, s 39; matsumoto, t 39; kumar, a 37; kumar, s 36; kim, hj 35; zhang, lm 34; yamauchi, m 34; yamashita, y 34; wang, ch 34; uno, s 34; uehara, s 34; tian, xc 34; teramoto, y 34; tanaka, m 34

Sources
physical review b 50; physical review letters 49; physical review d 46; physics letters b 44; physical review c 29; journal of chemical physics 28; physical review a 27; astrophysical journal 26; astronomy & astrophysics 24; pramana-journal of physics 22; journal of physics g-nuclear and particle physics 17; indian journal of pure & applied physics 17; spectrochimica acta part a-molecular and biomolecular spectroscopy 16; physica b-condensed matter 16; journal of applied physics 16; european physical journal c 16; european physical journal a 16; physical review e 15; journal of physics b-atomic molecular and optical physics 15; international journal of quantum chemistry 15

Keywords
physics, multidisciplinary 189; physics, atomic, molecular & chemical 115; physics, condensed matter 103; physics, nuclear 87; astronomy & astrophysics 80; physics, particles & fields 75; physics, applied 66; physics, particles & fields 65; optics 62; chemistry, physical 49; model 49; physics, fluids & plasmas 35; systems 32; spectra 31; physics, mathematical 31; spectroscopy 30; optics 28; dynamics 28; spectroscopy 27; states 27

Publication Year
2005 1044; 2006 15; 2004 5

Country
india 1064; usa 220; germany 155; russia 118; peoples r china 112; france 97; japan 95; south korea 83; taiwan 65; poland 64; england 63; switzerland 61; netherlands 52; brazil 52; italy 50; australia 48; canada 40; sweden 38; czech republic 38; austria 35

Institution
indian inst technol 124; tata inst fundamental res 120; inst high energy phys 85; panjab univ 76; bhabha atom res ctr 75; korea univ 67; univ sci & technol china 63; princeton univ 63; indian inst sci 61; inst theoret & expt phys 57; univ tokyo 56; univ tsukuba 50; tokyo inst technol 49; brookhaven natl lab 49; chinese acad sci 48; saha inst nucl phys 47; yonsei univ 45; univ delhi 45; seoul natl univ 45; natl cent univ 45

DataBase
science citation index 1064

Citations
eidelman s, 2004, phys lett b, v592, p1 53; adler ss, 2003, phys rev lett, v91 44; kurokawa s, 2003, nucl instrum meth a, v499, p1 33; abashian a, 2002, nucl instrum meth a, v479, p117 33; sjostrand t, 2001, comput phys commun, v135, p238 24; lee c, 1988, phys rev b, v37, p785 23; fox gc, 1978, phys rev lett, v41, p1581 20; adams j, 2004, phys rev lett, v92 19; albrecht h, 1990, phys lett b, v241, p278 18; becke ad, 1993, j chem phys, v98, p5648 16; parr rg, 1989, density functional t 15; frisch mj, 1998, gaussian 98 revision 15; adler ss, 2004, phys rev c, v69 15; adams j, 2003, phys rev lett, v91 15; adcox k, 2002, phys rev lett, v88 14; abe k, 2002, phys rev d, v66 14; kohn w, 1965, phys rev, v140, a1133 13; brun r, 1984, ddee841 cern 13; kakuno h, 2004, nucl instrum meth a, v533, p516 12; hohenberg p, 1964, phys rev b, v136, p864 12

CLUSTER 20

- **FILM PHYSICS**

(1576 Records)

Cluster Syntax Features

Descriptive Terms
film 8.6%, temperatur 5.6%, phase 2.2%, crystal 2.1%, alloi 1.9%, composit 1.9%, glass 1.8%, magnet 1.6%, deposit 1.5%, rai 1.3%, sampl 1.3%, conduct 1.2%, ion 1.1%, dope 1.0%, structur 1.0%, properti 1.0%, powder 1.0%, diffract 0.9%, size 0.9%, (38.72%)

Single Word Terms
temperatur 863, structur 495, rai 484, phase 464, properti 462, electron 430, diffract 393, composit 390, sampl 371, film 363, size 335, high 334, measur 331, energi 306, crystal 303, materi 296, transit 279, ion 274, conduct 273, format 271

Double Word Terms
rai.diffract 345, room.temperatur 204, thin.film 184, electron.microscopi 179, scan.electron 145, transmiss.electron 115, diffract.xrd 112, activ.energi 106, singl.crystal 101, particl.size 98, low.temperatur 91, band.gap 87, transit.temperatur 87, solid.state 83, high.temperatur 82, temperatur.depend 79, optic.absorpt 73, film.deposit 72, electr.conduct 70, glass.substrat 68

Triple Word Terms
rai.diffract.xrd 105, scan.electron.microscopi 90, transmiss.electron.microscopi 85, powder.rai.diffract 51, fourier.transform.infrar 47, electron.microscopi.sem 43, optic.band.gap 41, scan.electron.microscop 39, solid.state.reaction 38, energi.dispers.rai 36, atom.forc.microscopi 36, rai.photoelectron.spectroscopi 31, electron.microscopi.tem 29, thin.film.deposit 27, transform.infrar.spectroscopi 26, glass.transit.temperatur 25, verlag.gmbh.kgaa 24, differenti.scan.calorimetri 24, electron.microscop.sem 23, rai.powder.diffract 23

Cluster Metrics

Authors
kumar, a 26; malik, sk 25; avasthi, dk 22; kumar, s 20; tyagi, ak 17; rao, jl 15; nigam, ak 15; chaudhuri, s 15; bahadur, d 15; singh, s 14; ravi, v 14; kumar, r 14; gupta, a 14; rao, cnr 13; ghosh, a 12; das, s 12; singh, f 11; kumar, v 11; ghosh, s 11; choudhary, rnp 11

Sources
journal of applied physics 76; bulletin of materials science 52; materials letters 46; physica b-condensed matter 42; pramana-journal of physics 39; physical review b 39; indian journal of physics and proceedings of the indian association for the cultivation of science 39; materials chemistry and physics 34; solid state communications 31; journal of crystal growth 27; indian journal of pure & applied physics 27; materials science and engineering b-solid state materials for advanced technology 26; applied physics letters

26; crystal research and technology 22; materials research bulletin 21; journal of the american ceramic society 21; journal of nanoscience and nanotechnology 21; journal of magnetism and magnetic materials 21; journal of non-crystalline solids 20; materials science and engineering a-structural materials properties microstructure and processing 19

Keywords
materials science, multidisciplinary 419; physics, condensed matter 168; physics, applied 156; physics, condensed matter 133; physics, multidisciplinary 120; chemistry, physical 120; physics, applied 117; materials science, multidisciplinary 107; films 81; temperature 79; behavior 73; materials science, ceramics 72; growth 67; engineering 66; metallurgy & metallurgical 66; chemistry, multidisciplinary 65; thin-films 65; crystallography 63; microstructure 60; system 59

Publication Year
2005 1508; 2006 53; 2004 15

Country
india 1576; usa 71; japan 71; germany 62; south korea 37; france 34; taiwan 20; england 18; peoples r china 17; italy 11; spain 10; switzerland 6; russia 6; mexico 6; malaysia 6; brazil 6; israel 5; australia 5; singapore 4; poland 4

Institution
indian inst technol 254; indian inst sci 97; bhabha atom res ctr 81; tata inst fundamental res 64; indian assoc cultivat sci 57; natl phys lab 46; natl chem lab 46; ctr nucl sci 36; cent glass & ceram res inst 36; banaras hindu univ 36; sri venkateswara univ 33; univ delhi 32; indira gandhi ctr atom res 30; anna univ 29; cent electrochem res inst 27; shivaji univ 24; chinese acad sci 23; jawaharlal nehru ctr adv sci res 22; inst phys 22; ctr adv technol 22

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Citations
shannon rd, 1976, acta crystallogr a, v32, p751 24; zener c, 1951, phys rev, v82, p403 19; kurtz sk, 1968, j appl phys, v39, p3798 19; macdonald jr, 1987, impedance spectrosco 14; jonscher ak, 1977, nature, v267, p673 14; rao cnr, 1998, colossal magnetoresi 13; ofelt gs, 1962, j chem phys, v37, p511 13; hwang hy, 1996, phys rev lett, v77, p2041 13; millis aj, 1995, phys rev lett, v74, p5144 12; judd br, 1962, phys rev, v127, p750 12; jonscher ak, 1983, dielectric relaxatio 12; ingram md, 1987, phys chem glasses, v28, p215 12; davis ea, 1970, philos mag, v22, p903 12; chopra kl, 1983, thin solid films, v102, p1 12; weil ja, 1994, elect paramagnetic r, p498 11; vonhelmolt r, 1993, phys rev lett, v71, p2331 11; urushibara a, 1995, phys rev b, v51, p14103 11; mott nf, 1968, j noncryst solids, v1, p1 11; macedo pb, 1972, phys chem glasses, v13, p171 11; jin s, 1994, science, v264, p413 11

CLUSTER 20 HAS TWO MAIN THRUSTS: CLUST 6 AND CLUST 0

CLUSTER 6
- **SMALL-SCALE FILM MEASUREMENTS**

(1166 Records)

Cluster Syntax Features

Descriptive Terms
temperatur 6.6%, crystal 3.6%, phase 3.3%, alloi 2.7%, magnet 2.5%, composit 2.4%, glass 2.1%, sampl 1.7%, powder 1.6%, rai 1.4%, transit 1.3%, dielectr 1.2%, particl 1.2%, conduct 1.1%, diffract 1.1%, dope 1.1%, structur 1.1%, properti 1.0%, size 0.9%, ion 0.9%

Discriminating Terms
temperatur 3.5%, crystal 2.6%, alloi 2.5%, glass 1.8%, phase 1.6%, magnet 1.6%, powder 1.4%, composit 1.3%, model 1.0%, dielectr 1.0%, patient 1.0%, diffract 0.9%, dope 0.9%, rai 0.9%, acid 0.7%, rai.diffract 0.7%, transit 0.7%, complex 0.7%, xrd 0.6%, sampl 0.6%

Single Word Terms
temperatur 673, phase 399, rai 365, structur 357, properti 328, electron 312, composit 310, diffract 302, sampl 298, crystal 277, high 252, size 244, transit 242, materi 240, measur 234, energi 223, state 218, format 214, thermal 209, powder 209

Double Word Terms
rai.diffract 260, room.temperatur 152, electron.microscopi 118, singl.crystal 96, transmiss.electron 91, scan.electron 90, diffract.xrd 90, particl.size 81, solid.state 80, transit.temperatur 79, activ.energi 79, high.temperatur 75, low.temperatur 74, temperatur.depend 60, powder.rai 56, dielectr.constant 54, phase.transit 53, electr.conduct 49, optic.absorpt 48, solid.solut 47

Triple Word Terms
rai.diffract.xrd 83, transmiss.electron.microscopi 64, scan.electron.microscopi 52, powder.rai.diffract 50, solid.state.reaction 37, fourier.transform.infrar 33, scan.electron.microscop 28, electron.microscopi.sem 27, rai.powder.diffract 23, energi.dispers.rai 22, differenti.scan.calorimetri 22, verlag.gmbh.kgaa 22, electron.microscopi.tem 21, electron.paramagnet.reson 21, glass.transit.temperatur 20, transmiss.electron.microscop 19, transform.infrar.spectroscopi 19, rai.photoelectron.spectroscopi 18, paramagnet.reson.epr 18, vch.verlag.gmbh 17

Term Cliques
23.57% sampl powder rai particl diffract properti size
24.38% composit sampl powder rai particl diffract properti
21.96% magnet sampl particl diffract properti size

20.71% alloi composit particl properti
26.28% phase sampl powder rai diffract properti size
27.53% phase composit sampl powder rai diffract structur properti
25.45% phase alloi composit properti
27.04% crystal phase sampl powder rai diffract structur
24.39% temperatur glass sampl conduct dope properti ion
29.60% temperatur composit sampl transit structur properti ion
26.27% temperatur composit glass sampl conduct properti ion
25.13% temperatur composit glass sampl dielectr conduct properti
27.10% temperatur composit glass sampl transit properti ion
25.96% temperatur composit glass sampl transit dielectr properti
27.69% temperatur magnet sampl properti size ion
26.25% temperatur magnet sampl transit dope structur properti ion
24.07% temperatur magnet glass sampl transit dope properti ion
31.97% temperatur phase sampl rai diffract properti size
29.18% temperatur phase composit sampl transit dielectr structur properti
29.99% temperatur phase composit sampl rai dielectr diffract structur properti
29.77% temperatur phase magnet sampl diffract properti size
31.16% temperatur phase magnet sampl diffract structur properti
30.42% temperatur phase magnet sampl transit structur properti
27.10% temperatur crystal sampl transit dope structur ion
28.93% temperatur crystal phase sampl transit dielectr structur
29.87% temperatur crystal phase sampl rai dielectr diffract structur

Cluster Metrics

Authors
malik, sk 22; tyagi, ak 15; rao, jl 15; nigam, ak 15; bahadur, d 15; ravi, v 14; kumar, s 14; chaudhuri, s 13; kumar, a 12; ghosh, a 12; rao, cnr 11; gupta, a 11; choudhary, rnp 11; nirmala, r 10; gopal, no 10; chakradhar, rps 10; singh, s 9; singh, k 9; sebastian, mt 9; ramasamy, p 9

Sources
journal of applied physics 54; bulletin of materials science 42; physical review b 34; materials letters 34; physica b-condensed matter 31; indian journal of physics and proceedings of the indian association for the cultivation of science 29; pramana-journal of physics 28; solid state communications 27; materials chemistry and physics 23; journal of crystal growth 22; indian journal of pure & applied physics 22; materials science and engineering b-solid state materials for advanced technology 21; journal of the american ceramic society 20; journal of magnetism and magnetic materials 20; materials science and engineering a-structural materials properties microstructure and processing 19; crystal research and technology 19; journal of alloys and compounds 18; journal of materials science 17; applied physics letters 17; spectrochimica acta part a-molecular and biomolecular spectroscopy 16

Keywords

materials science, multidisciplinary 307; physics, condensed matter 136; physics, applied 114; physics, condensed matter 93; physics, multidisciplinary 92; chemistry, physical 88; materials science, multidisciplinary 87; temperature 65; materials science, ceramics 64; physics, applied 63; behavior 57; engineering 55; crystallography 55; metallurgy & metallurgical 55; films 55; system 52; chemistry, multidisciplinary 50; microstructure 45; x-ray diffraction 41; nanoparticles 38

Publication Year
2005 1110; 2006 43; 2004 13

Country
india 1166; japan 62; usa 54; germany 52; france 27; south korea 18; england 15; peoples r china 13; taiwan 12; spain 10; italy 7; russia 6; brazil 6; malaysia 5; switzerland 4; canada 4; singapore 3; poland 3; greece 3; australia 3

Institution
indian inst technol 204; indian inst sci 78; bhabha atom res ctr 67; tata inst fundamental res 55; indian assoc cultivat sci 45; natl chem lab 43; banaras hindu univ 30; cent glass & ceram res inst 27; anna univ 27; sri venkateswara univ 26; natl phys lab 23; indira gandhi ctr atom res 22; def met res lab 20; chinese acad sci 19; natl met lab 18; csir 18; tohoku univ 17; natl inst technol 17; jawaharlal nehru ctr adv sci res 17; osmania univ 16

DataBase
science citation index 1166

Citations
shannon rd, 1976, acta crystallogr a, v32, p751 24; kurtz sk, 1968, j appl phys, v39, p3798 19; zener c, 1951, phys rev, v82, p403 18; ofelt gs, 1962, j chem phys, v37, p511 13; macdonald jr, 1987, impedance spectrosco 12; judd br, 1962, phys rev, v127, p750 12; jonscher ak, 1983, dielectric relaxatio 12; jonscher ak, 1977, nature, v267, p673 12; ingram md, 1987, phys chem glasses, v28, p215 12; weil ja, 1994, elect paramagnetic r, p498 11; macedo pb, 1972, phys chem glasses, v13, p171 11; jin s, 1994, science, v264, p413 11; urushibara a, 1995, phys rev b, v51, p14103 10; rao cnr, 1998, colossal magnetoresi 10; millis aj, 1995, phys rev lett, v74, p5144 10; hwang hy, 1996, phys rev lett, v77, p2041 10; duffy ja, 1975, j inorg nucl chem, v37, p1203 10; davis ea, 1970, philos mag, v22, p903 10; vonhelmolt r, 1993, phys rev lett, v71, p2331 9; snyder gj, 1996, phys rev b, v53, p14434 9

CLUSTER 0

- **FILM DEPOSITION AND GROWTH**

(410 Records)

Cluster Syntax Features

Descriptive Terms

film 43.4%, deposit 7.1%, thin.film 3.6%, thin 3.3%, substrat 2.1%, coat 2.0%, temperatur 1.2%, optic 0.9%, anneal 0.7%, thick 0.6%, ion 0.6%, surfac 0.5%, conduct 0.5%, irradi 0.5%, film.deposit 0.5%, resist 0.5%, electr 0.4%, glass 0.4%, rai 0.4%, properti 0.4%

Discriminating Terms
film 31.2%, deposit 4.7%, thin.film 2.6%, thin 2.1%, coat 1.1%, substrat 1.1%, model 0.7%, patient 0.6%, acid 0.5%, complex 0.5%, activ 0.5%, compound 0.5%, system 0.5%, reaction 0.5%, two 0.4%, anneal 0.4%, cell 0.4%, protein 0.4%, film.deposit 0.4%, product 0.3%

Single Word Terms
film 342, deposit 215, thin 195, temperatur 190, substrat 178, structur 138, properti 134, rai 119, electron 118, optic 114, surfac 111, coat 100, conduct 99, measur 97, glass 94, size 91, diffract 91, thick 90, microscopi 87, resist 87

Double Word Terms
thin.film 183, rai.diffract 85, film.deposit 72, glass.substrat 67, electron.microscopi 61, band.gap 56, scan.electron 55, room.temperatur 52, substrat.temperatur 39, film.thick 37, atom.forc 35, grain.size 33, deposit.film 31, forc.microscopi 31, optic.band 29, sol.gel 29, properti.film 27, activ.energi 27, surfac.morpholog 27, optic.properti 26

Triple Word Terms
scan.electron.microscopi 38, atom.forc.microscopi 31, optic.band.gap 29, thin.film.deposit 27, rai.diffract.xrd 22, transmiss.electron.microscopi 21, film.rai.diffract 18, forc.microscopi.afm 16, puls.laser.deposit 16, electron.microscopi.sem 16, coat.glass.substrat 16, energi.dispers.rai 14, fourier.transform.infrar 14, rai.photoelectron.spectroscopi 13, swift.heavi.ion 13, clean.glass.substrat 11, scan.electron.microscop 11, electr.optic.properti 10, zno.thin.film 10, averag.grain.size 9

Term Cliques
16.34% ion conduct irradi
20.24% ion surfac irradi rai
25.06% coat ion surfac properti
24.15% coat ion surfac rai
25.24% coat optic ion properti
24.33% coat optic ion rai
28.57% deposit substrat coat anneal film.deposit resist glass properti
28.11% deposit substrat coat anneal film.deposit resist glass rai
29.09% deposit substrat coat anneal surfac film.deposit resist properti
28.63% deposit substrat coat anneal surfac film.deposit resist rai
29.39% deposit substrat coat optic anneal film.deposit glass properti
28.93% deposit substrat coat optic anneal film.deposit glass rai
39.82% film ion surfac properti
38.90% film ion surfac rai
39.09% film optic ion rai

36.83% film optic ion conduct properti
34.90% film thin.film thin substrat temperatur anneal conduct film.deposit resist electr glass properti
35.50% film thin.film thin substrat temperatur anneal thick conduct resist electr glass
35.45% film thin.film thin substrat temperatur optic anneal conduct film.deposit electr glass properti
36.10% film thin.film thin substrat temperatur optic anneal thick conduct electr glass
36.46% film deposit substrat anneal surfac film.deposit resist properti
36.01% film deposit substrat anneal surfac film.deposit resist rai
38.40% film deposit thin.film thin substrat temperatur anneal film.deposit resist glass rai
37.26% film deposit thin.film thin substrat temperatur anneal film.deposit resist electr glass properti
39.00% film deposit thin.film thin substrat temperatur optic anneal film.deposit glass rai
37.80% film deposit thin.film thin substrat temperatur optic anneal film.deposit electr glass properti

Cluster Metrics

Authors
avasthi, dk 18; kumar, a 14; agnihotry, sa 10; singh, f 9; mangalaraj, d 9; lokhande, cd 9; verma, a 7; tripathi, sk 7; narayandass, sk 7; menon, cs 7; thakur, a 6; saini, gss 6; saikia, d 6; kumar, s 6; goyal, n 6; bakhshi, ak 6; yakhmi, jv 5; vijayakumar, kp 5; singh, s 5; sharma, v 5

Sources
journal of applied physics 22; applied surface science 17; thin solid films 15; surface engineering 13; materials letters 12; sensors and actuators b-chemical 11; pramana-journal of physics 11; physica b-condensed matter 11; materials chemistry and physics 11; journal of optoelectronics and advanced materials 10; indian journal of physics and proceedings of the indian association for the cultivation of science 10; bulletin of materials science 10; solar energy materials and solar cells 9; applied physics letters 9; nuclear instruments & methods in physics research section b-beam interactions with materials and atoms 8; surface & coatings technology 6; journal of nanoscience and nanotechnology 6; physical review b 5; materials science and engineering b-solid state materials for advanced technology 5; materials research bulletin 5

Keywords
materials science, multidisciplinary 112; physics, applied 54; physics, applied 42; physics, condensed matter 40; physics, 35; thin-films 33; physics, condensed matter 32; chemistry, physical 32; growth 32; physics, multidisciplinary 28; materials science, coatings & films 28; films 26; engineering, electrical & electronic 23; thin films 22; deposition 22; materials science, multidisciplinary 20; electrochemistry 20; thin-films 18; condensed matter 18; optical-properties 18

Publication Year
2005 398; 2006 10; 2004 2

Country
india 410; south korea 19; usa 17; germany 10; japan 9; taiwan 8; france 7; peoples r china 4; mexico 4; italy 4; israel 3; ireland 3; england 3; switzerland 2; netherlands 2; australia 2; south africa 1; slovakia 1; singapore 1; portugal 1

Institution
indian inst technol 50; natl phys lab 23; ctr nucl sci 22; univ delhi 21; indian inst sci 19; cent electrochem res inst 18; shivaji univ 15; bhabha atom res ctr 14; inst phys 12; indian assoc cultivat sci 12; cochin univ sci & technol 11; bharathiar univ 10; tata inst fundamental res 9; cent glass & ceram res inst 9; alagappa univ 9; solid state phys lab 8; saha inst nucl phys 8; indira gandhi ctr atom res 8; univ poona 7; tezpur univ 7

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CLUSTER 16

- **FILM CHEMISTRY**

(1291 Records)

Cluster Syntax Features

Descriptive Terms
adsorpt 3.0%, concentr 2.7%, polym 2.6%, ion 2.6%, dye 2.2%, solut 1.9%, blend 1.8%, surfact 1.7%, water 1.6%, acid 1.5%, membran 1.3%, micel 1.1%, aqueou 1.0%, composit 1.0%, surfac 0.9%, temperatur 0.9%, resin 0.9%, properti 0.7%, electrod 0.7%, (30.82%)

Single Word Terms
concentr 506, solut 385, temperatur 367, acid 330, water 314, ion 271, properti 266, aqueou 264, time 263, surfac 260, rate 242, paramet 236, high 232, composit 229, system 219, carri 212, two 206, polym 201, phase 199, mechan 196

Double Word Terms
aqueou.solut 111, differenti.scan 77, scan.electron 76, electron.microscopi 70, scan.calorimetri 67, mechan.properti 65, thermal.stabil 59, metal.ion 59, first.order 55, molecular.weight 54, mobil.phase 51, activ.energi 48, rate.constant 46, tensil.strength 45, fourier.transform 43, poli.vinyl 42, sodium.dodecyl 41, ion.exchang 41, room.temperatur 41, thermodynam.paramet 40

Triple Word Terms
differenti.scan.calorimetri 66, scan.electron.microscopi 55, fourier.transform.infrar 38, glass.transit.temperatur 34, scan.calorimetri.dsc 28, sodium.dodecyl.sulfat 26, flow.rate.min 24, dynam.light.scatter 23, poli.vinyl.alcohol 23, first.order.kinet 22, critic.micel.concentr 22, time.resolv.fluoresc 21, dodecyl.sulfat.sd 20, pseudo.first.order 20, electron.microscopi.sem 18, pseudo.second.order 17, transform.infrar.ftir 17, micel.concentr.cmc 15, rel.standard.deviat 15, second.order.kinet 15

Cluster Metrics

Authors
kumar, s 22; singh, b 17; pal, a 17; mukherjee, t 15; thomas, s 14; basu, s 14; gupta, vk 13; nath, s 11; ghosh, sk 11; bakshi, ms 11; sridhar, s 10; sastry, m 10; pal, t 10; moulik, sp 10; kundu, s 10; kumar, r 10; kumar, a 10; singh, ak 9; panigrahi, s 9; aminabhavi, tm 9

Sources
asian journal of chemistry 65; journal of applied polymer science 49; journal of polymer materials 42; journal of colloid and interface science 38; journal of the indian chemical society 32; journal of physical chemistry b 29; indian journal of chemical technology 26; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 25; colloids and surfaces a-physicochemical and engineering aspects

18; journal of hazardous materials 17; polymer international 16; journal of reinforced plastics and composites 16; journal of pharmaceutical and biomedical analysis 16; chemical physics letters 16; separation and purification technology 15; journal of macromolecular science-pure and applied chemistry 15; talanta 14; langmuir 14; polymer 13; european polymer journal 12

Keywords
polymer science 206; chemistry, physical 181; chemistry, multidisciplinary 181; chemistry, analytical 126; water 81; adsorption 79; engineering, chemical 73; engineering, chemical 70; chemistry, applied 70; kinetics 67; behavior 54; polymer science 53; adsorption 45; sorption 45; materials science, multidisciplinary 43; environmental sciences 41; acid 41; polymers 37; removal 36; physics, atomic, molecular & chemical 35

Publication Year
2005 1200; 2006 62; 2004 29

Country
india 1291; usa 28; germany 21; japan 14; south korea 13; canada 10; france 9; england 6; australia 6; peoples r china 5; italy 5; portugal 3; iran 3; sweden 2; new zealand 2; netherlands 2; israel 2; belgium 2; taiwan 1; switzerland 1

Institution
indian inst technol 177; bhabha atom res ctr 54; indian inst sci 44; anna univ 43; indian inst chem technol 35; natl chem lab 34; jadavpur univ 34; indian assoc cultivat sci 25; csir 25; aligarh muslim univ 24; guru nanak dev univ 23; cent electrochem res inst 20; univ delhi 19; univ bombay 18; reg res lab 17; mahatma gandhi univ 17; cent leather res inst 17; cent food technol res inst 17; banaras hindu univ 14; andhra univ 14

DataBase
science citation index 1291

Citations
kalyanasundaram k, 1977, j am chem soc, v99, p2039 14; weber wj, 1963, j sanitary engineeri, v89, p31 13; sarkar n, 1996, j phys chem-us, v100, p15483 12; oconnor dv, 1984, time correlated sing 12; langmuir i, 1918, j am chem soc, v40, p1361 12; lakowicz jr, 1999, principles fluoresce 12; bhattacharyya k, 2003, accounts chem res, v36, p95 12; rubingh dn, 1979, solution chem surfac, v1, p337 11; nandi n, 2000, chem rev, v100, p2013 11; flory pj, 1953, principles polym che 11; clint jh, 1975, j chem soc farad t 1, v71, p1327 11; rosen mj, 1989, surfactants interfac 10; mckay g, 1981, j colloid interf sci, v80, p323 10; maroncelli m, 1987, j chem phys, v86, p6221 10; fendler jh, 1982, membrane mimetic che 10; bhattacharyya k, 2000, j phys chem a, v104, p10603 10; weber tw, 1974, aiche j, v20, p228 9; lagergren s, 1898, kungliga svenska vet, v24, p1 9; huang rym, 1991, pervaporation membra 9; ho ys, 1999, process biochem, v34, p451 9

CLUSTER 16 HAS TWO MAIN THRUSTS: CLUST 4 AND CLUST 8

CLUSTER 4

- **POLYMER CHEMISTRY/ PROPERTIES**

(479 Records)

Cluster Syntax Features

Descriptive Terms
polym 8.8%, blend 7.6%, membran 2.8%, composit 2.7%, resin 2.6%, copolym 2.5%, poli 2.0%, properti 1.9%, thermal 1.4%, crosslink 1.3%, graft 1.3%, strength 1.0%, polymer 0.9%, mechan 0.8%, temperatur 0.8%, cure 0.8%, acid 0.8%, stabil 0.8%, scan 0.7%, weight 0.7%

Discriminating Terms
polym 7.0%, blend 6.6%, resin 2.2%, copolym 2.1%, membran 1.8%, poli 1.6%, crosslink 1.2%, composit 1.1%, graft 1.0%, model 0.8%, patient 0.8%, cure 0.7%, polymer 0.6%, properti 0.6%, complex 0.6%, thermal 0.5%, rubber 0.5%, compound 0.5%, activ 0.5%, mechan.properti 0.5%

Single Word Terms
properti 184, temperatur 174, polym 169, composit 163, thermal 140, mechan 132, concentr 121, scan 121, poli 120, acid 112, water 101, high 99, strength 99, weight 94, stabil 94, solut 92, synthes 90, blend 89, chemic 88, electron 85

Double Word Terms
differenti.scan 74, mechan.properti 64, scan.electron 63, scan.calorimetri 63, thermal.stabil 53, electron.microscopi 52, molecular.weight 46, tensil.strength 45, transit.temperatur 37, glass.transit 35, poli.vinyl 34, fourier.transform 31, transform.infrar 29, calorimetri.dsc 27, activ.energi 25, dynam.mechan 25, rai.diffract 25, vinyl.alcohol 23, cross.link 22, methyl.methacryl 21

Triple Word Terms
differenti.scan.calorimetri 63, scan.electron.microscopi 45, glass.transit.temperatur 34, fourier.transform.infrar 29, scan.calorimetri.dsc 27, poli.vinyl.alcohol 22, electron.microscopi.sem 15, transform.infrar.spectroscopi 14, vinyl.alcohol.pva 13, gel.permeat.chromatographi 12, interpenetr.polym.network 11, poli.methyl.methacryl 11, transform.infrar.ftir 11, scan.electron.microscop 10, poli.ethylen.glycol 9, dynam.mechan.thermal 9, properti.tensil.strength 9, styren.butadien.rubber 9, methyl.methacryl.pmma 8, high.molecular.weight 8

Term Cliques
20.50% thermal cure stabil scan weight
22.09% thermal mechan cure stabil scan
23.73% copolym properti thermal polymer scan weight
19.86% copolym properti thermal crosslink graft polymer scan

20.67% resin properti thermal graft polymer
27.52% composit thermal strength temperatur scan weight
25.14% composit properti thermal strength cure scan weight
26.27% composit properti thermal strength mechan cure scan
26.30% composit copolym thermal temperatur scan weight
24.70% composit copolym thermal crosslink temperatur scan
26.65% composit copolym properti thermal scan weight
25.05% composit copolym properti thermal crosslink scan
24.52% composit resin properti thermal strength mechan cure
27.38% blend composit thermal strength mechan temperatur scan
27.68% blend composit properti thermal strength mechan scan
26.16% blend composit properti thermal crosslink mechan scan
24.01% blend membran composit thermal crosslink mechan temperatur scan
24.40% polym copolym thermal polymer temperatur stabil scan weight
23.40% polym copolym poli thermal crosslink polymer temperatur acid stabil scan
22.07% polym copolym poli thermal crosslink graft polymer temperatur acid scan
23.17% polym membran poli thermal crosslink polymer temperatur acid stabil scan
21.84% polym membran poli thermal crosslink graft polymer temperatur acid scan
23.80% polym blend membran poli thermal crosslink mechan temperatur stabil scan

Cluster Metrics

Authors
thomas, s 14; sridhar, s 10; aminabhavi, tm 9; singh, b 8; siddaramaiah 8; kumar, s 8; kumar, r 8; smitha, b 7; sekhon, ss 7; kapadi, ur 7; hundiwale, dg 7; das, ck 7; bhowmick, ak 7; kumar, a 6; asthana, sn 6; ashraf, sm 6; raju, km 5; rai, sk 5; mohan, ym 5; bajpai, ak 5

Sources
journal of applied polymer science 47; journal of polymer materials 41; journal of reinforced plastics and composites 16; polymer international 15; journal of macromolecular science-pure and applied chemistry 14; polymer 13; polymer-plastics technology and engineering 11; journal of materials science 9; indian journal of physics and proceedings of the indian association for the cultivation of science 9; european polymer journal 9; journal of the indian chemical society 7; macromolecules 6; journal of scientific & industrial research 6; journal of polymer science part b-polymer physics 6; journal of membrane science 6; polymers & polymer composites 5; journal of polymer science part a-polymer chemistry 5; asian journal of chemistry 5; radiation measurements 4; pigment & resin technology 4

Keywords
polymer science 194; polymer science 40; behavior 34; engineering, chemical 31; polymers 31; chemistry, multidisciplinary 29; composites 28; materials science, composites 27; morphology 25; materials science, multidisciplinary 23; composites 21; chemistry, physical 21; chemistry, analytical 19; water 18; blends 18; kinetics 17; viscosity 16; temperature 16; rubber 15; mechanical-properties 14

Publication Year
2005 440; 2004 26; 2006 13

Country
india 479; usa 14; south korea 7; germany 7; france 5; peoples r china 4; england 3; australia 3; japan 2; canada 2; taiwan 1; singapore 1; portugal 1; north ireland 1; new zealand 1; netherlands 1; italy 1; israel 1; belgium 1

Institution
indian inst technol 57; indian inst sci 25; indian inst chem technol 23; anna univ 20; natl chem lab 19; mahatma gandhi univ 17; cent food technol res inst 12; univ mysore 11; sri krishnadevaraya univ 10; jadavpur univ 10; n maharashtra univ 9; karnatak univ 9; guru nanak dev univ 9; indian assoc cultivat sci 8; cent leather res inst 8; univ bombay 7; jamia millia islamia 7; himachal pradesh univ 7; cent salt & marine chem res inst 7; bhabha atom res ctr 7

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science citation index 479

Citations
flory pj, 1953, principles polym che 10; huang rym, 1991, pervaporation membra 9; wijmans jg, 1995, j membrane sci, v107, p1 7; toti us, 2004, j membrane sci, v228, p198 6; sperling lh, 1981, interpenetrating pol 6; kurkuri md, 2002, j appl polym sci, v86, p3642 6; doyle cd, 1961, anal chem, v33, p77 6; bledzki ak, 1999, prog polym sci, v24, p221 6; toti us, 2002, j appl polym sci, v85, p2014 5; sridhar s, 2000, ind eng chem res, v39, p2485 5; kreuer kd, 2001, j membrane sci, v185, p29 5; jeong b, 1997, nature, v388, p860 5; harogoppad sb, 1991, macromolecules, v24, p2598 5; crank j, 1975, math diffusion 5; bajpai sk, 2001, j appl polym sci, v80, p2782 5; aminabhavi tm, 2002, j appl polym sci, v83, p273 5; aminabhavi ta, 2002, j appl polym sci, v83, p244 5; ahmad s, 1999, j appl polym sci, v72, p1679 5; tzou k, 1993, synthetic met, v53, p365 4; singh yp, 1983, eur polym j, v19, p535 4

CLUSTER 8

- **SURFACE WET CHEMISTRY**

(812 Records)

Cluster Syntax Features

Descriptive Terms
adsorpt 5.8%, dye 4.0%, ion 4.0%, concentr 3.5%, surfact 3.3%, solut 2.2%, micel 2.1%, water 1.6%, aqueou 1.5%, electrod 1.2%, adsorb 1.2%, acid 1.2%, fluoresc 1.2%, remov 1.1%, surfac 1.0%, sodium 0.9%, cation 0.8%, nanoparticl 0.7%, carbon 0.7%, micellar 0.7%

Discriminating Terms
adsorpt 5.8%, dye 3.9%, surfact 3.3%, ion 2.2%, micel 2.2%, concentr 1.5%, adsorb 1.2%, electrod 1.1%, aqueou 1.1%, patient 0.9%, solut 0.9%, fluoresc 0.9%, remov 0.8%, micellar 0.7%, sodium 0.6%, cation 0.6%, nanoparticl 0.5%, model 0.5%, compound 0.5%, structur 0.5%

Single Word Terms
concentr 385, solut 293, ion 223, acid 218, aqueou 215, water 213, time 198, temperatur 193, surfac 183, rate 178, paramet 166, adsorpt 157, sodium 145, phase 143, carri 142, system 135, high 133, kinet 133, data 133, form 132

Double Word Terms
aqueou.solut 98, first.order 52, mobil.phase 51, metal.ion 49, rate.constant 42, sodium.dodecyl 41, adsorpt.isotherm 37, flow.rate 37, detect.limit 36, free.energi 35, order.kinet 35, activ.carbon 34, thermodynam.paramet 34, contact.time 33, second.order 32, ion.exchang 32, cation.surfact 31, surfac.area 31, steadi.state 31, revers.phase 30

Triple Word Terms
sodium.dodecyl.sulfat 26, flow.rate.min 23, critic.micel.concentr 21, dodecyl.sulfat.sd 20, pseudo.first.order 20, time.resolv.fluoresc 20, first.order.kinet 19, dynam.light.scatter 18, pseudo.second.order 17, second.order.kinet 15, rel.standard.deviat 15, micel.concentr.cmc 14, sodium.dodecyl.sulphat 14, first.order.rate 13, critic.micellar.concentr 13, thin.layer.chromatograph 13, glassi.carbon.electrod 13, langmuir.adsorpt.isotherm 13, ammonium.bromid.ctab 12, steadi.state.fluoresc 12

Term Cliques
18.18% aqueou electrod surfac sodium cation
19.11% aqueou electrod acid surfac carbon
14.58% surfact fluoresc surfac sodium nanoparticl
17.32% surfact aqueou surfac sodium nanoparticl
14.92% surfact micel fluoresc surfac sodium cation micellar
15.45% surfact micel water fluoresc sodium cation micellar
26.34% concentr solut aqueou acid remov surfac carbon
22.40% concentr surfact solut micel aqueou surfac sodium cation micellar
22.81% concentr surfact solut micel water aqueou sodium cation micellar
19.27% ion aqueou sodium nanoparticl
19.16% ion aqueou electrod sodium cation
22.29% ion aqueou electrod acid
27.48% ion concentr solut aqueou adsorb remov
28.17% ion concentr solut water aqueou sodium cation
29.17% ion concentr solut water aqueou acid remov
13.45% dye surfact fluoresc surfac nanoparticl
16.18% dye surfact aqueou surfac nanoparticl
14.11% dye surfact micel fluoresc surfac cation micellar
21.77% dye concentr surfact solut micel aqueou surfac cation micellar
22.54% adsorpt dye concentr solut aqueou adsorb remov surfac carbon

24.26% adsorpt dye concentr surfact solut aqueou surfac cation

Cluster Metrics

Authors
pal, a 16; mukherjee, t 14; kumar, s 14; gupta, vk 13; basu, s 13; nath, s 11; ghosh, sk 11; bakshi, ms 11; sastry, m 10; pal, t 10; kundu, s 10; singh, b 9; singh, ak 9; panigrahi, s 9; moulik, sp 9; palanivelu, k 8; pal, h 8; kumbhakar, m 8; sankar, dg 7; roy, s 7

Sources
asian journal of chemistry 60; journal of colloid and interface science 34; journal of physical chemistry b 27; journal of the indian chemical society 25; indian journal of chemical technology 24; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 21; colloids and surfaces a-physicochemical and engineering aspects 18; journal of pharmaceutical and biomedical analysis 15; journal of hazardous materials 15; chemical physics letters 15; langmuir 14; separation and purification technology 12; bulletin of electrochemistry 12; talanta 11; dyes and pigments 11; spectrochimica acta part a-molecular and biomolecular spectroscopy 10; water research 9; colloid and polymer science 9; sensors and actuators b-chemical 8; journal of chemical sciences 8

Keywords
chemistry, physical 160; chemistry, multidisciplinary 152; chemistry, analytical 107; adsorption 76; water 63; engineering, chemical 63; chemistry, applied 56; kinetics 50; adsorption 44; engineering, chemical 39; environmental sciences 37; sorption 35; removal 34; ions 31; physics, atomic, molecular & chemical 29; fluorescence 29; electrochemistry 28; acid 27; oxidation 25; spectroscopy 24

Publication Year
2005 760; 2006 49; 2004 3

Country
india 812; usa 14; germany 14; japan 12; canada 8; south korea 6; italy 4; france 4; iran 3; england 3; australia 3; sweden 2; portugal 2; switzerland 1; spain 1; saudi arabia 1; romania 1; peoples r china 1; pakistan 1; new zealand 1

Institution
indian inst technol 120; bhabha atom res ctr 47; jadavpur univ 24; anna univ 23; aligarh muslim univ 23; indian inst sci 19; csir 19; cent electrochem res inst 18; univ delhi 17; indian assoc cultivat sci 17; natl chem lab 15; guru nanak dev univ 14; saha inst nucl phys 13; reg res lab 13; andhra univ 13; indian inst chem technol 12; banaras hindu univ 12; univ bombay 11; univ madras 9; s gujarat univ 9

DataBase
science citation index 812

Citations
kalyanasundaram k, 1977, j am chem soc, v99, p2039 14; weber wj, 1963, j sanitary engineeri, v89, p31 13; sarkar n, 1996, j phys chem-us, v100, p15483 12; oconnor dv, 1984, time correlated sing 12; langmuir i, 1918, j am chem soc, v40, p1361 12; bhattacharyya k, 2003, accounts chem res, v36, p95 12; rubingh dn, 1979, solution chem surfac, v1, p337 11; nandi n, 2000, chem rev, v100, p2013 11; lakowicz jr, 1999, principles fluoresce 11; clint jh, 1975, j chem soc farad t 1, v71, p1327 11; rosen mj, 1989, surfactants interfac 10; mckay g, 1981, j colloid interf sci, v80, p323 10; maroncelli m, 1987, j chem phys, v86, p6221 10; fendler jh, 1982, membrane mimetic che 10; bhattacharyya k, 2000, j phys chem a, v104, p10603 10; weber tw, 1974, aiche j, v20, p228 9; lagergren s, 1898, kungliga svenska vet, v24, p1 9; ho ys, 1999, process biochem, v34, p451 9; hall kr, 1966, ind eng chem fund, v5, p212 9; edward jt, 1970, j chem educ, v47, p261 9

CLUSTER 19

- **CHEMICAL BONDS/ CRYSTAL STRUCTURE**

(939 Records)

Cluster Syntax Features

Descriptive Terms
complex 16.7%, dot 7.3%, center 6.4%, ligand 3.9%, bond 3.6%, hydrogen 2.3%, hydrogen.bond 1.9%, structur 1.9%, crystal 1.9%, molecul 1.8%, ring 1.5%, conform 1.1%, interact 1.0%, compound 1.0%, titl 1.0%, iii 0.9%, angstrom 0.9%, titl.compound 0.7%, form 0.7%, (57.09%)

Single Word Terms
complex 523, structur 427, bond 343, crystal 297, two 291, ligand 288, form 280, interact 271, hydrogen 266, molecul 240, compound 238, center 205, electron 203, synthes 198, on 195, metal 190, ring 182, stabil 174, element 170, molecular 168

Double Word Terms
hydrogen.bond 224, crystal.structur 150, titl.compound 122, schiff.base 64, singl.crystal 61, magnet.suscept 61, metal.ion 56, water.molecul 54, molar.conduct 53, intermolecular.hydrogen 51, ligand.complex 51, solid.state 47, octahedr.geometri 47, rai.diffract 47, complex.element 46, dot.hydrogen 46, metal.complex 45, crystal.rai 45, complex.type 44, room.temperatur 43

Triple Word Terms
intermolecular.hydrogen.bond 46, center.dot.hydrogen 46, singl.crystal.rai 44, dot.hydrogen.bond 38, hydrogen.bond.interact 34, magnet.suscept.measur 32, element.molar.conduct 28, van.der.waal 23, center.dot.h2o 23, crystal.rai.diffract 21, center.dot.interact 20, hydrogen.bond.form 20, mix.ligand.complex 19, crystal.structur.stabil 18, rai.crystal.structur 18, densiti.function.theori 17, intramolecular.hydrogen.bond 17, structur.titl.compound 17, intermolecular.center.dot 16, distort.octahedr.geometri 16

Cluster Metrics

Authors
ravikumar, k 42; velmurugan, d 27; selvanayagam, s 20; sharma, r 16; raghunathan, r 16; sridhar, b 15; sharma, s 15; nethaji, m 15; fun, hk 15; chandra, s 15; rajaram, rk 13; natarajan, s 13; yathirajan, hs 12; sharma, rp 12; bala, r 12; singh, tp 11; kumar, r 10; drew, mgb 10; srinivasan, pc 9; singh, n 9

Sources
acta crystallographica section e-structure reports online 126; asian journal of chemistry 56; journal of the indian chemical society 48; spectrochimica acta part a-molecular and biomolecular spectroscopy 42; transition metal chemistry 39; inorganic chemistry 27; polyhedron 23; indian journal of chemistry section a-inorganic bio-inorganic physical

theoretical & analytical chemistry 21; inorganica chimica acta 18; european journal of inorganic chemistry 16; journal of organometallic chemistry 15; journal of physical chemistry a 14; journal of molecular structure 14; journal of coordination chemistry 14; journal of chemical crystallography 14; synthesis and reactivity in inorganic metal-organic and nano-metal chemistry 13; chemical communications 13; inorganic chemistry communications 12; acta crystallographica section c-crystal structure communications 12; journal of molecular structure-theochem 10

Keywords
chemistry, multidisciplinary 210; chemistry, inorganic & nuclear 199; crystallography 183; chemistry, physical 92; crystal-structure 72; complexes 67; ligands 62; crystal-structure 60; spectroscopy 55; derivatives 53; chemistry 51; complexes 49; biochemistry & molecular biology 46; chemistry, organic 38; acid 37; spectroscopy 36; crystallography 36; crystal structure 36; cobalt(ii) 34; nickel(ii) 33

Publication Year
2005 927; 2006 9; 2004 3

Country
india 939; usa 48; germany 32; england 30; spain 22; peoples r china 15; malaysia 15; taiwan 14; italy 12; france 11; japan 10; scotland 9; switzerland 8; poland 8; czech republic 7; australia 5; netherlands 4; canada 4; norway 3; fiji 3

Institution
indian inst technol 88; indian inst sci 77; indian inst chem technol 56; univ madras 44; univ hyderabad 40; bharathidasan univ 31; jadavpur univ 30; indian assoc cultivat sci 28; bhabha atom res ctr 28; madurai kamaraj univ 26; univ delhi 24; univ mysore 21; univ burdwan 21; univ rajasthan 19; univ calcutta 17; univ poona 15; natl chem lab 15; aligarh muslim univ 15; univ sains malaysia 14; univ barcelona 13

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science citation index 939

Citations
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CLUSTER 19 HAS TWO MAIN THRUSTS: CLUST 2 AND CLUST 1

CLUSTER 2

- **LIGAND-METAL COMPLEX SYNTHESES**

(460 Records)

Cluster Syntax Features

Descriptive Terms
complex 38.6%, ligand 9.2%, iii 2.1%, metal 1.4%, spectral 1.0%, nmr 0.9%, copper 0.8%, synthes 0.8%, coordin 0.7%, geometri 0.7%, element 0.7%, h2o 0.7%, electron 0.6%, magnet 0.6%, bind 0.5%, ion 0.5%, schiff.base 0.5%, schiff 0.5%, clo4 0.5%, spectra 0.4%

Discriminating Terms
complex 25.8%, ligand 6.6%, iii 1.0%, model 0.8%, patient 0.6%, temperatur 0.6%, phase 0.5%, system 0.5%, cell 0.4%, level 0.4%, coordin 0.4%, film 0.4%, h2o 0.4%, spectral 0.4%, concentr 0.4%, copper 0.4%, metal 0.4%, nmr 0.4%, time 0.4%, high 0.4%

Single Word Terms
complex 425, ligand 247, synthes 161, structur 155, metal 152, element 152, electron 144, spectral 138, two 123, magnet 122, nmr 121, form 111, reaction 108, ion 105, iii 104, data 104, geometri 102, spectra 98, conduct 96, measur 94

Double Word Terms
magnet.suscept 58, schiff.base 55, ligand.complex 50, molar.conduct 49, metal.ion 49, octahedr.geometri 46, complex.element 44, metal.complex 44, complex.type 42, magnet.moment 38, copper.complex 37, iii.complex 35, crystal.structur 33, complex.complex 31, conduct.measur 31, spectral.data 30, distort.octahedr 30, electron.spectra 30, suscept.measur 29, element.molar 29

Triple Word Terms
magnet.suscept.measur 29, element.molar.conduct 27, singl.crystal.rai 24, mix.ligand.complex 19, molar.conduct.magnet 16, calf.thymu.dna 15, distort.octahedr.geometri 15, complex.gener.formula 14, squar.planar.geometri 13, octahedr.geometri.complex 13, element.molecular.weight 13, complex.element.molar 13, schiff.base.ligand 13, conduct.magnet.suscept 13, vch.verlag.gmbh 12, complex.squar.planar 11, verlag.gmbh.kgaa 11, kgaa.69451.weinheim 11, element.conduct.measur 11, gmbh.kgaa.69451 11

Term Cliques
31.86% complex ligand nmr copper coordin geometri bind ion spectra
29.06% complex ligand metal spectral copper synthes coordin geometri electron magnet ion schiff.base schiff clo4 spectra

30.38% complex ligand metal spectral nmr copper synthes coordin geometri element electron magnet ion schiff.base schiff spectra
31.26% complex ligand iii coordin geometri h2o bind ion spectra
28.25% complex ligand iii metal synthes coordin geometri h2o magnet ion schiff.base schiff clo4 spectra
29.95% complex ligand iii metal synthes coordin geometri element h2o magnet ion schiff.base schiff spectra
29.49% complex ligand iii metal spectral synthes coordin geometri electron magnet ion schiff.base schiff clo4 spectra
31.09% complex ligand iii metal spectral synthes coordin geometri element electron magnet ion schiff.base schiff spectra

Cluster Metrics

Authors
chandra, s 15; nethaji, m 9; gupta, lk 9; sharma, s 8; patil, sa 7; kumar, a 7; gudasi, kb 7; vadavi, rs 6; sinha, c 6; shenoy, rv 6; sarkar, s 6; ramesh, r 6; raman, n 6; patil, ms 6; kollipara, mr 6; drew, mgb 6; bhattacharya, s 6; viswanathan, m 5; singh, n 5; singh, ks 5

Sources
asian journal of chemistry 54; journal of the indian chemical society 46; transition metal chemistry 35; spectrochimica acta part a-molecular and biomolecular spectroscopy 29; indian journal of chemistry section a-inorganic bio-inorganic physical theoretical & analytical chemistry 19; polyhedron 18; inorganic chemistry 18; journal of organometallic chemistry 13; european journal of inorganic chemistry 13; synthesis and reactivity in inorganic metal-organic and nano-metal chemistry 12; inorganica chimica acta 12; journal of coordination chemistry 9; polish journal of chemistry 8; inorganic chemistry communications 7; main group metal chemistry 5; dalton transactions 5; applied organometallic chemistry 5; journal of thermal analysis and calorimetry 4; journal of scientific & industrial research 4; journal of molecular structure 4

Keywords
chemistry, multidisciplinary 163; chemistry, inorganic & nuclear 149; ligands 48; complexes 44; complexes 39; crystal-structure 37; spectroscopy 33; nickel(ii) 33; cobalt(ii) 33; metal-complexes 29; derivatives 29; chemistry 29; crystal-structure 28; chemistry, physical 26; coordination 26; copper(ii) 25; chemistry, organic 25; synthesis 23; crystallography 22; cu(ii) 19

Publication Year
2005 453; 2006 7

Country
india 460; usa 22; spain 16; england 14; taiwan 12; germany 10; japan 8; peoples r china 6; czech republic 6; italy 5; switzerland 3; scotland 3; france 3; fiji 3; canada 3; australia 3; poland 2; malaysia 2; ethiopia 1; brazil 1

Institution
indian inst technol 35; univ delhi 20; jadavpur univ 19; univ rajasthan 18; univ burdwan 17; indian inst sci 16; indian assoc cultivat sci 13; bhabha atom res ctr 12; aligarh muslim univ 12; univ hyderabad 10; univ barcelona 10; bharathidasan univ 10; univ calcutta 9; ne hill univ 9; karnatak univ 9; univ allahabad 8; banaras hindu univ 8; univ poona 7; univ kalyani 7; univ reading 6

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CLUSTER 1

- **COMPOUND HYDROGEN BONDS**

(479 Records)

Cluster Syntax Features

Descriptive Terms
dot 15.6%, center 12.5%, bond 6.5%, hydrogen 4.8%, hydrogen.bond 4.1%, molecul 3.2%, crystal 3.0%, ring 3.0%, structur 2.5%, conform 2.4%, titl 2.3%, angstrom 1.8%, titl.compound 1.8%, compound 1.5%, interact 1.3%, crystal.structur 0.9%, form 0.8%, intermolecular 0.7%, atom 0.7%, dimer 0.6%

Discriminating Terms
dot 11.0%, center 8.4%, bond 4.0%, hydrogen.bond 3.0%, hydrogen 2.9%, molecul 1.7%, ring 1.7%, titl 1.6%, conform 1.5%, titl.compound 1.3%, crystal 1.2%, angstrom 1.2%, model 0.7%, temperatur 0.7%, patient 0.6%, crystal.structur 0.6%, activ 0.5%, concentr 0.5%, structur 0.5%, intermolecular 0.4%

Single Word Terms
structur 272, bond 269, hydrogen 238, crystal 223, molecul 193, interact 187, compound 178, form 169, two 168, titl 146, ring 146, center 145, conform 134, dot 128, on 120, molecular 107, stabil 104, acid 102, complex 98, intermolecular 89

Double Word Terms
hydrogen.bond 205, titl.compound 122, crystal.structur 117, intermolecular.hydrogen 47, dot.hydrogen 46, water.molecul 37, dihedr.angl 36, bond.interact 36, singl.crystal 32, solid.state 30, rai.diffract 30, asymmetr.unit 28, amino.acid 25, crystal.pack 25, benzen.ring 24, three.dimension 24, side.chain 23, structur.stabil 22, densiti.function 22, unit.cell 22

Triple Word Terms
center.dot.hydrogen 46, intermolecular.hydrogen.bond 42, dot.hydrogen.bond 38, hydrogen.bond.interact 31, van.der.waal 21, hydrogen.bond.form 20, center.dot.interact 20, singl.crystal.rai 20, intramolecular.hydrogen.bond 17, crystal.structur.stabil 17, structur.titl.compound 17, molecul.asymmetr.unit 16, intermolecular.center.dot 16, center.dot.h2o 15, unit.cell.paramet 13, densiti.function.theori 13, form.hydrogen.bond 12, crystal.structur.titl 12, three.dimension.structur 12, crystal.rai.diffract 11

Term Cliques
35.15% bond hydrogen hydrogen.bond molecul crystal ring conform titl compound interact crystal.structur form intermolecular dimer
34.45% bond hydrogen hydrogen.bond molecul crystal ring conform titl titl.compound compound interact crystal.structur intermolecular dimer
37.03% bond hydrogen hydrogen.bond molecul crystal ring structur conform compound interact crystal.structur form intermolecular dimer
34.68% dot bond hydrogen hydrogen.bond molecul crystal structur angstrom compound interact crystal.structur form intermolecular atom dimer
33.90% dot bond hydrogen hydrogen.bond molecul crystal ring titl compound interact crystal.structur form intermolecular atom dimer
33.25% dot bond hydrogen hydrogen.bond molecul crystal ring titl titl.compound compound interact crystal.structur intermolecular atom dimer
35.66% dot bond hydrogen hydrogen.bond molecul crystal ring structur compound interact crystal.structur form intermolecular atom dimer
34.02% dot center bond hydrogen hydrogen.bond crystal structur angstrom compound interact crystal.structur form intermolecular atom dimer
33.24% dot center bond hydrogen hydrogen.bond crystal ring titl compound interact crystal.structur form intermolecular atom dimer
32.58% dot center bond hydrogen hydrogen.bond crystal ring titl titl.compound compound interact crystal.structur intermolecular atom dimer
34.99% dot center bond hydrogen hydrogen.bond crystal ring structur compound interact crystal.structur form intermolecular atom dimer

Cluster Metrics

Authors
ravikumar, k 42; velmurugan, d 27; selvanayagam, s 20; sridhar, b 15; raghunathan, r 15; rajaram, rk 13; natarajan, s 13; fun, hk 13; yathirajan, hs 12; singh, tp 11; sharma, r 11;

srinivasan, pc 9; sharma, rp 9; ramakrishnan, v 9; bala, r 9; sridhar, ma 8; prasad, js 8; dey, s 8; desiraju, gr 8; athimoolam, s 8

Sources
acta crystallographica section e-structure reports online 125; spectrochimica acta part a-molecular and biomolecular spectroscopy 13; journal of chemical crystallography 13; acta crystallographica section c-crystal structure communications 12; journal of physical chemistry a 11; journal of molecular structure 10; journal of molecular structure-theochem 9; inorganic chemistry 9; crystengcomm 9; crystal growth & design 9; chemical communications 9; journal of physical chemistry b 8; journal of photochemistry and photobiology a-chemistry 7; acta crystallographica section d-biological crystallography 7; inorganica chimica acta 6; chemical physics letters 6; biopolymers 6; tetrahedron 5; structural chemistry 5; polyhedron 5

Keywords
crystallography 177; chemistry, physical 66; chemistry, inorganic & nuclear 50; chemistry, multidisciplinary 47; biochemistry & molecular biology 39; crystal-structure 35; crystal-structure 32; spectroscopy 25; derivatives 24; complexes 23; acid 23; spectroscopy 22; chemistry 22; biophysics 22; crystal structure 21; crystal-structures 20; chemistry, organic 19; physics, atomic, molecular & chemical 16; binding 16; hydrogen bonding 15

Publication Year
2005 474; 2004 3; 2006 2

Country
india 479; usa 26; germany 22; england 16; malaysia 13; peoples r china 9; france 8; italy 7; spain 6; scotland 6; poland 6; switzerland 5; netherlands 4; norway 3; denmark 3; belgium 3; taiwan 2; sweden 2; singapore 2; japan 2

Institution
indian inst sci 61; indian inst technol 53; indian inst chem technol 53; univ madras 40; univ hyderabad 30; madurai kamaraj univ 26; univ mysore 21; bharathidasan univ 21; bhabha atom res ctr 16; indian assoc cultivat sci 15; univ sains malaysia 13; anna univ 13; all india inst med sci 12; jadavpur univ 11; jawaharlal nehru ctr adv sci res 10; univ jammu 9; natl chem lab 9; univ poona 8; univ calcutta 8; punjabi univ 8

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sheldrick gm, 1990, acta crystallogr a, v46, p467 26; allen fh, 1987, j chem soc p2, s1 26; sheldrick gm, 1996, sadabs 21; farrugia lj, 1999, j appl crystallogr, v32, p837 18; desiraju gr, 1999, weak hydrogen bond s 18; desiraju gr, 1995, angew chem int edit, v34, p2311 18; *bruk axs inc, 2001, saint vers 6 28a sma 18; nardelli m, 1983, acta crystallogr c, v39, p1141 17; harms k, 1995, xcad4 17; flack hd, 1983, acta crystallogr a, v39, p876 17; jeffrey ga, 1991, hydrogen bonding bio 15

CLUSTER 9

- **REACTIONS/ CATALYSIS/ SYNTHESIS**

(1298 Records)

Cluster Syntax Features

Descriptive Terms
reaction 11.9%, catalyst 4.4%, synthesi 4.0%, yield 3.7%, acid 3.5%, compound 3.2%, substitut 2.2%, oxid 1.7%, synthes 1.4%, aryl 1.0%, methyl 1.0%, deriv 1.0%, condens 1.0%, activ 1.0%, aldehyd 0.9%, afford 0.9%, product 0.9%, beta 0.7%, step 0.7%, ester 0.7%

Discriminating Terms
reaction 8.0%, catalyst 3.3%, synthesi 2.8%, yield 2.0%, substitut 1.3%, compound 1.2%, acid 1.1%, model 0.8%, aryl 0.8%, patient 0.8%, aldehyd 0.7%, condens 0.7%, afford 0.7%, synthes 0.6%, methyl 0.6%, oxid 0.5%, cell 0.5%, ester 0.5%, film 0.5%, level 0.5%

Single Word Terms
reaction 660, acid 408, yield 393, compound 327, activ 326, synthesi 322, product 254, synthes 250, condit 250, substitut 237, catalyst 231, oxid 217, temperatur 213, on 209, deriv 205, effici 179, correspond 176, rate 174, format 164, kinet 159

Double Word Terms
first.order 78, room.temperatur 71, reaction.condit 70, high.yield 56, spectral.data 55, acet.acid 55, on.pot 50, microwav.irradi 49, reaction.rate 44, solvent.free 44, synthes.compound 43, compound.screen 38, rate.reaction 37, afford.correspond 37, acid.medium 37, effici.synthesi 36, rate.constant 36, nmr.mass 36, catalyt.activ 36, alpha.beta 34

Triple Word Terms
solvent.free.condit 32, reaction.first.order 28, alpha.beta.unsatur 27, on.pot.synthesi 19, nmr.mass.spectral 19, mass.spectral.data 19, first.order.depend 18, first.order.kinet 17, mild.reaction.condit 17, dielectr.constant.medium 14, pseudo.first.order 14, structur.synthes.compound 13, spectral.data.compound 13, compound.basi.element 13, beer.law.obei 12, compound.screen.antibacteri 12, phase.transfer.catalyst 11, solid.acid.catalyst 11, acet.acid.medium 10, diel.alder.reaction 10

Term Cliques
15.70% aryl activ product beta
12.80% compound deriv condens aldehyd afford beta ester
13.27% compound methyl deriv condens afford beta ester
11.66% compound aryl condens aldehyd afford beta ester
14.75% compound aryl condens activ aldehyd beta
12.13% compound aryl methyl condens afford beta ester
15.31% compound aryl methyl condens activ beta

20.97% acid aryl activ product
15.37% acid substitut methyl condens step ester
18.25% acid substitut methyl condens activ step
16.47% acid compound substitut synthes deriv condens aldehyd afford ester
16.84% acid compound substitut synthes methyl deriv condens afford ester
15.58% acid compound substitut synthes aryl condens aldehyd afford ester
18.39% acid compound substitut synthes aryl condens activ aldehyd
15.95% acid compound substitut synthes aryl methyl condens afford ester
18.81% acid compound substitut synthes aryl methyl condens activ
14.36% yield aryl afford product beta ester
12.38% yield aryl condens aldehyd afford beta ester
17.87% yield acid aryl afford product ester
15.76% yield acid substitut aryl condens aldehyd afford ester
14.70% synthesi deriv beta ester
18.84% synthesi acid step ester
19.97% synthesi acid deriv ester
16.21% synthesi yield aryl beta ester
20.43% synthesi yield acid aryl ester
19.12% reaction deriv afford product beta ester
17.31% reaction deriv aldehyd afford beta ester
24.58% reaction methyl activ beta
17.86% reaction methyl deriv afford beta ester
24.19% reaction acid product step ester
22.64% reaction acid deriv afford product ester
25.82% reaction acid oxid activ product step
24.56% reaction acid oxid methyl activ step
26.87% reaction acid substitut activ aldehyd
20.46% reaction acid substitut deriv aldehyd afford ester
21.94% reaction acid substitut methyl step ester
24.82% reaction acid substitut methyl activ step
20.93% reaction acid substitut methyl deriv afford ester
21.53% reaction yield afford product beta ester
19.72% reaction yield aldehyd afford beta ester
25.05% reaction yield acid afford product ester
22.53% reaction yield acid substitut aldehyd afford ester
24.73% reaction catalyst activ product beta
22.56% reaction catalyst activ aldehyd beta
26.91% reaction catalyst acid oxid activ product
25.10% reaction catalyst acid oxid activ aldehyd
23.19% reaction catalyst yield afford product beta
21.38% reaction catalyst yield aldehyd afford beta
26.71% reaction catalyst yield acid afford product
24.90% reaction catalyst yield acid aldehyd afford

Cluster Metrics

Authors
yadav, js 28; kumar, a 17; reddy, pn 15; yadav, gd 14; rajitha, b 13; kumar, s 13; kumar, p 13; singh, b 12; kumar, r 12; srikrishna, a 11; reddy, yt 11; reddy, bvs 11; singh, ak 10; nair, v 10; kantam, ml 10; singh, p 9; narayana, b 9; kumar, bs 9; halligudi, sb 9; sharma, a 8

Sources
tetrahedron letters 144; indian journal of chemistry section b-organic chemistry including medicinal chemistry 113; asian journal of chemistry 78; synthetic communications 54; indian journal of heterocyclic chemistry 53; journal of the indian chemical society 50; journal of molecular catalysis a-chemical 45; journal of chemical research-s 36; synlett 34; tetrahedron 31; synthesis-stuttgart 29; journal of organic chemistry 28; journal of heterocyclic chemistry 25; tetrahedron-asymmetry 20; oxidation communications 19; applied catalysis a-general 18; heterocyclic communications 17; organic letters 16; letters in organic chemistry 16; journal of applied polymer science 14

Keywords
chemistry, organic 593; chemistry, multidisciplinary 267; derivatives 131; chemistry, physical 121; oxidation 75; chemistry, organic 68; acid 61; chemistry, inorganic & nuclear 60; synthesis 55; alcohols 54; kinetics 50; chemistry, applied 47; derivatives 46; chemistry 46; aldehydes 42; mechanism 40; chemistry, physical 40; polymer science 39; chemistry, medicinal 39; complexes 38

Publication Year
2005 1270; 2006 19; 2004 9

Country
india 1298; usa 25; germany 16; japan 13; france 12; england 8; spain 5; denmark 5; taiwan 4; south korea 4; peoples r china 4; italy 4; netherlands 3; switzerland 2; south africa 2; hungary 2; bangladesh 2; austria 2; wales 1; sweden 1

Institution
indian inst chem technol 113; indian inst technol 106; natl chem lab 86; indian inst sci 42; cent drug res inst 34; univ madras 29; bangalore univ 26; csir 23; natl inst technol 21; univ bombay 20; jadavpur univ 20; univ delhi 19; univ mysore 17; karnatak univ 17; mangalore univ 16; andhra univ 16; univ allahabad 15; reg res lab 15; guru nanak dev univ 15; univ rajasthan 14

DataBase
science citation index 1298

Citations
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tetrahedron, v57, p9225 12; yadav gd, 1999, micropor mesopor mat, v33, p1 11; trnka tm, 2001, accounts chem res, v34, p18 11; srivastava n, 2003, j org chem, v68, p2109 11; loupy a, 1998, synthesis-stuttg sep, p1213 11; biginelli p, 1893, gazz chim ital, v23, p360 11; beck js, 1992, j am chem soc, v114, p10834 11; patil ad, 1995, j org chem, v60, p1182 10; okuhara t, 1996, adv catal, v41, p113 10; ranu bc, 2000, j org chem, v65, p6270 9; campbell mm, 1978, chem rev, v78, p65 9; basavaiah d, 2003, chem rev, v103, p811 9; balasubramanian k, 1986, indian j chem b, v25, p326 9