

# STUDY OF RESEARCH PRODUCTIVITY, CITATION PATTERNS AND COLLABORATION NETWORKS IN PUBLICATIONS OF IISER BHOPAL DURING 2011-2015

Hiteshkumar Solanki\*, Pallab Pradhan\*, Sanjeev Jain\*\*\*

**Abstract** This paper attempts to study the various bibliometrics parameters of research outputs along with citations of IISER Bhopal published during 2011-2015, and indexed in Web of Science Core Collection database limited to only internal indexes such as: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH. A total of 464 publications were selected for this study which are limited to only articles, conference proceedings, books, and book chapters. All those publications had received a total of 6060 citations with an average of 13.06 citations per publication. Further, annual average growth trends of publications, average citations per paper, top highly productive authors, authorship patterns and networks, bibliographic coupling using Salton's normalized index, keywords cluster analysis of prominent research areas, and countries collaboration have been explored using Bibliometrix, R package and BibExcel tools.

**Keywords:** Indian Institute of Science Education and Research, IISERs, IISER Bhopal, Citation Analysis, H-index, Salton's Index, Keywords Clustering, Bibliographic Coupling, Authorship Patterns, Co-authorship Networks, Collaboration Networks

## INTRODUCTION

The “Indian Institutes of Science Education and Research (IISERs)” were established after the recommendation by the Scientific Advisory Council to the Prime Minister (SAC-PM) under the Chairmanship of Prof. C.N.R. Rao for the creation of new institutions devoted to science research and education broadly on the lines of Indian Institute of Science (IISc), Bangalore. Seven such Institutes have already been established so far in the country. The first two IISERs (Pune and Kolkata) were established in 2006. This was followed by an Institute at Mohali (2007), Bhopal & Trivandrum (2008), Tirupati (2015), and Berhampur (2016). IISERs were incorporated as Institutions of National Importance under the umbrella of the NIT (Amendment) Act, 2012 (NIT Act 2007). The Act was further amended in 2014, entitled the NITSER ACT 2014. Each IISER is a degree-granting autonomous institute ([https://en.wikipedia.org/wiki/Indian\\_Institutes\\_of\\_Science\\_Education\\_and\\_Research](https://en.wikipedia.org/wiki/Indian_Institutes_of_Science_Education_and_Research)). The vision of these institutes encompasses creation of research centres of the highest calibre where teaching and education in the basic sciences are integrated with state-of-the-art research. These Institutions are devoted to under-graduate and post-graduate teaching in the basic sciences in an intellectually vibrant atmosphere of research (<http://www.iisersystem.ac.in/>).

IISER Bhopal was established in 2008. Its vision is to provide high quality education to undergraduate, postgraduate, and doctoral students. The Institute also aspires to contribute to the society through teaching and research to help achieve global sustainability. Further, the Institute aims to produce leaders in science and related disciplines (<https://www.iiserb.ac.in/institute/visionMission>).

This article presents a study of detailed analysis of the research output of IISER Bhopal published during 2011-2015. An attempt has been made to analyse and explore annual average growth trends of publications, average citations per papers, top highly productive authors, authorship patterns and networks, coupling strength through bibliographic coupling, most prominent research areas by cluster analysis, and at last the international collaboration is calculated.

## RELATED WORKS

In the past, few evaluation studies have been carried out based on research outputs especially of IISERs. Visakhi, Gupta & Gupta (2015) analysed 2542 research publications of the then five Indian Institutes of Science Education & Research (IISERs) published during 2010-14, as covered

\* Information and Library Network (INFLIBNET) Centre, Gandhinagar, Gujarat, India.  
Email: [hitesh@inflibnet.ac.in](mailto:hitesh@inflibnet.ac.in); [pallab@inflibnet.ac.in](mailto:pallab@inflibnet.ac.in)

\*\* National Institute of Fashion Technology, NIFT Campus, Gandhinagar, Gujarat, India.  
Email: [sanjeev.jain@nift.ac.in](mailto:sanjeev.jain@nift.ac.in)

in SCOPUS database. The study analysed characteristics of those publications such as the publication growth, research impact, national and international collaboration share, contribution and impact of authors and organizations, major areas of research, and preferred channels of research communications and characteristics of higher cited papers. Their findings revealed an annual average growth rate of 34.92% of IISERs publications and registered an average citation impact per paper of 9.90. And, the major areas of research were chemistry, physics & astronomy, materials science and biochemistry, genetics & molecular biology with institutional share of 43.94%, 34.19%, 24.86% and 19.71% during 2010-14. Solanki, Uddin & Singh (2016) measured the research competitiveness of Indian Institutes of Science Education and Research (IISERs) through a scientometric analysis of their research output during five years (2010–14). In that, a total of 2340 unique publication records contributed by IISERs were computed on the basis of well-known parameters like total papers (TP), total citations (TC), cited versus uncited papers, average citation per paper (ACPP), international collaborative papers (ICP), highly cited papers (HiCP), h-index1, g-index2, hg-index3, p-index4, etc. Pathak (2015) conducted an informetrics analysis of research papers published by the researchers and faculty of Institute of Science Education and Research (IISER) Bhopal during 2009-14 and indexed in Scopus database by focusing on its publication growth characteristics, format and media of communication, research impact and quality, patterns of research collaboration, broad and narrow areas of research and contribution and citation impact of its more productive authors. A total output of 328 papers during 2009-14 were analysed in that study.

## OBJECTIVES

Some of the main objectives of this study are:

- To measure the annual average growth of publications and citations of IISER Bhopal during the study period of 2011-2015,
- To find out the top highly productive authors,
- To identify and analyse the authorship patterns and co-authorship networks,
- To measure the coupling strength in between documents,
- To discover the most prominent research topics by analysing the keywords, and
- To explore the international collaboration based on first author's and each author's affiliation respectively.

## METHODOLOGY

### Sources of Data

The “Web of Science Core Collection” from Clarivate Analytics was used to obtain the publications and citations data of IISER Bhopal for the study period of 2011-2015.

### Data Collection

The study is limited to the research publications published from IISER Bhopal during 2011-2015 indexed in Web of Science Core Collection, further limited to only indexes such as: Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index- Science (CPCI-S), Conference Proceedings Citation Index- Social Science & Humanities (CPCI-SSH), Book Citation Index- Science (BKCI-S), Book Citation Index- Social Sciences & Humanities (BKCI-SSH). A total of 464 publications were indexed in the above mentioned database published from IISER Bhopal during the study period of 2011-2015. The data was collected on 10<sup>th</sup> November 2017 / Friday. The published materials such as article, book, book chapter, and proceedings paper were only considered as research publications for this study. The following advanced search query was used to extract the data from the above mentioned database:

(AD=((“INDIAN INSTITUTE OF SCIENCE EDUCATION RESEARCH IISER BHOPAL “ OR “ IISER “ OR “ INDIAN INST SCI EDUC RES IISER “ OR “ INDIAN INST SCI EDUC RES BHOPAL “ OR “ IISER BHOPAL “ OR “ INDIAN INST SCI EDUC RES IISER BHOPAL “ OR “ INDIAN INST SCI EDU RES “ OR “ INDIAN INST SCI EDUC “ OR “ INDIAN INST SCI EDUC RES “ OR “ INDIAN INST SCI RES EDUC “ OR “ IISERB “ ) SAME (“BHOPAL” OR “MP” OR “Madhya Pradesh”))

Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH Timespan=2011-2015

### Data Analysis

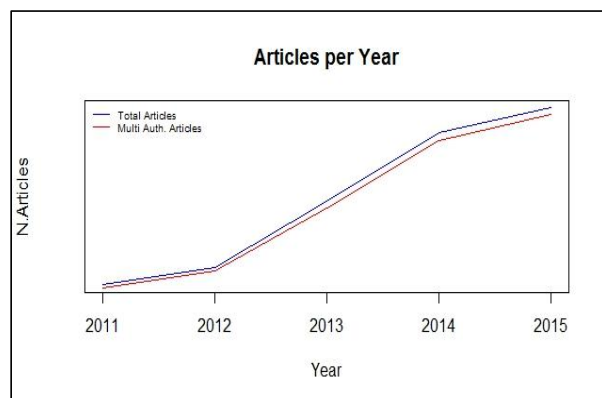
The “Bibliometrix”, R package was used to perform various quantitative analysis on the collected publications and citations data of IISER Bhopal. Further, the Bibexcel software along with Pajek tool was used to analyse and visualise keywords clustering and co-authorship networks.

## FINDINGS AND DISCUSSIONS

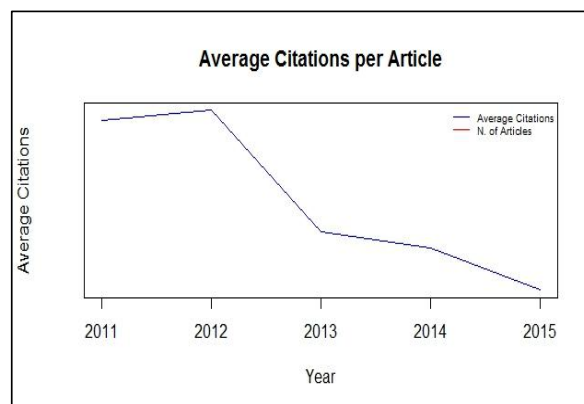
### Publications and Citations

A total of 464 publications were indexed in Web of Science Core Collection published during 2011-2015 from IISER Bhopal. Those 464 publications had received a total of 6060 citations including self-citations.

The annual percentage publications growth rate was 51.72913. And, the average citations per publication was 13.06. The Graph-1 shows the publications growth per year and the Graph-2 shows the average citations per publications. The Table 1 shows the year-wise number of publications, average citations, h-index of year-wise publications, etc. It can be observed that the publications from 2012 were having highest average with 25.6 citations per publication followed by 2011 with 24.67 citations.



Graph 1: Publications Growth Per Year



Graph 2: Average Citations Per Publications

Table 1: Year-Wise Publications & Citations, H-Index, Avg. Citations Per Publication, etc.

| Year  | Total Publications | h-index | Average citations per publication | Sum of Times Cited | Without self-citations | Citing articles |
|-------|--------------------|---------|-----------------------------------|--------------------|------------------------|-----------------|
| 2015  | 159                | 17      | 7.97                              | 1267               | 1067                   | 1102            |
| 2014  | 141                | 21      | 12.07                             | 1702               | 1362                   | 1407            |
| 2013  | 91                 | 20      | 13.74                             | 1250               | 1076                   | 1089            |
| 2012  | 43                 | 23      | 25.6                              | 1101               | 958                    | 966             |
| 2011  | 30                 | 13      | 24.67                             | 740                | 692                    | 695             |
| Total | 464                | 34      | 13.06                             | 6060               | 5892                   | 5259            |

### Authorship and Collaboration Pattern

All the bibliometrics aspects of authors and publications has been calculated using the “Bibliometrix”, R package. The

Table 2 summarised the details of authors and publications published from IISER Bhopal during the studied period 2011-2015.

Table 2: Authorship and Publications Pattern for Publications of IISER Bhopal

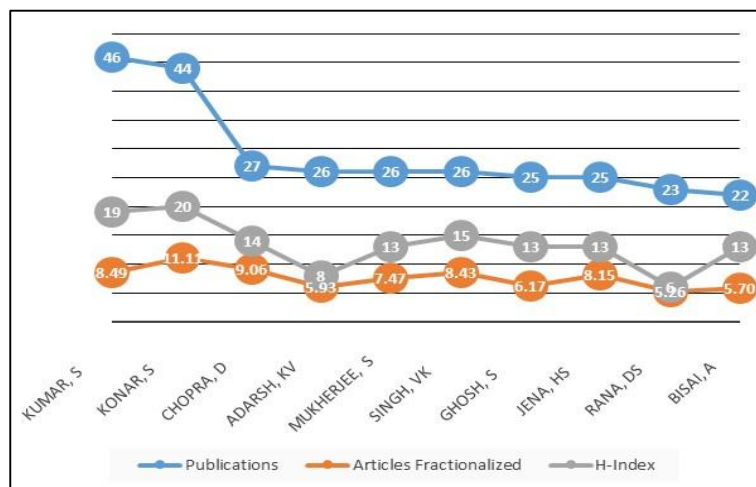
|                                         |       |
|-----------------------------------------|-------|
| Authors (Unique)                        | 832   |
| Author Appearances                      | 2079  |
| Authors of single authored publications | 2     |
| Authors of multi authored publications  | 830   |
| Articles per Author                     | 0.558 |
| Authors per publication                 | 1.79  |
| Co-Authors per Publications             | 4.48  |
| Collaboration Index                     | 1.87  |

The Table 3 and Graph 3 represent the most productive authors calculated on the basis of number of publications, publications fractionalization and h-index. It can be seen that no single author has same consistent performance in all three ranks/parameters. The author named Kumar, S

is on 1<sup>st</sup> rank in terms of number of publications but has lower rank in publications fractionalization (3) and h-index (2). As same, the author Konar, S is on 2<sup>nd</sup> rank in terms of number of publications but has top rank in publications fractionalization (1) and h-index (1).

**Table 3: Most Productive Authors on the Basis of Publications, Publications Fractionalization and H-index**

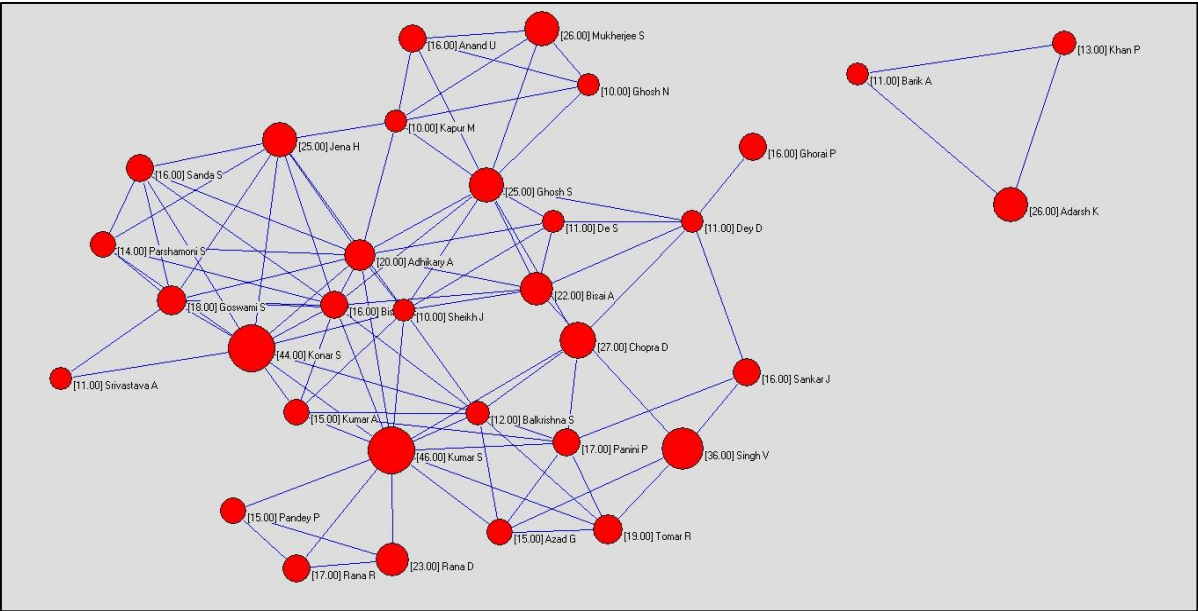
| Rank | Authors      | Publications | Authors        | Publications Fractionalized | Authors      | h-Index |
|------|--------------|--------------|----------------|-----------------------------|--------------|---------|
| 1    | Kumar, S     | 46           | Konar, S       | 11.11                       | Konar, S     | 20      |
| 2    | Konar, S     | 44           | Chopra, D      | 9.06                        | Kumar, S     | 19      |
| 3    | Chopra, D    | 27           | Kumar, S       | 8.49                        | Adhikary, A  | 16      |
| 4    | Adarsh, KV   | 26           | Singh, VK      | 8.43                        | Singh, VK    | 15      |
| 5    | Mukherjee, S | 26           | Jena, HS       | 8.15                        | Chopra, D    | 14      |
| 6    | Singh, VK    | 26           | Mahalakshmi, R | 7.70                        | Mukherjee, S | 13      |
| 7    | Ghosh, S     | 25           | Mukherjee, S   | 7.47                        | Ghosh, S     | 13      |
| 8    | Jena, HS     | 25           | Ghosh, S       | 6.17                        | Bisai, A     | 13      |
| 9    | Rana, DS     | 23           | Ghorai, P      | 6.17                        | Jena, HS     | 13      |
| 10   | Bisai, A     | 22           | Adarsh, KV     | 5.93                        | Goswami, S   | 12      |



**Graph 3: Most Productive Authors on the Basis of Publications, Publications Fractionalization and H-Index**

Further, the co-authorship network diagram has been generated as shown in Graph-4 to represent the joint works by two or more authors on publications. There were 832 unique authors from IISER Bhopal who had published 464 publications during 2011-2015. Among them, only 33 authors had more than 10 publications each which has been considered as cut-off for this analysis to generate

the co-authorship network diagram. In the diagram, each vertex (node) represents author and edge (line) represents collaborative publication(s) written by those connected authors. However, size of each vertex indicates number of publications published by a particular author which is mentioned in square braces [].



Graph 4: Co-Authorship Network Diagram

Bibliographic Coupling

As we know that bibliographic coupling occurs when two works/documents refer or cite one or more documents (third work) in common in their bibliographies or reference lists. It is an indication that a probability exists that the two works treat a related subject matter commonly. The “coupling

strength” of two given documents is higher the more citations to other documents they share ([https://en.wikipedia.org/wiki/Bibliographic\\_coupling](https://en.wikipedia.org/wiki/Bibliographic_coupling)). In this study, the strength of bibliographic coupling using Salton’s normalized index is calculated for the publications of IISER Bhopal. For representation, only the top ten tightly coupled documents/publications details have been listed in Table 4 and 5.

Table 4: Top Ten Tightly Coupled Documents as Per Salton’s Normalized Index

| Publication 1* | Publication 2* | References cited in Publication1 | References cited in Publication2 | Shared References | Salton's Index |
|----------------|----------------|----------------------------------|----------------------------------|-------------------|----------------|
| P4             | P10            | 49                               | 54                               | 45                | 0.8748         |
| P4             | P3             | 49                               | 53                               | 40                | 0.7849         |
| P16            | P13            | 3                                | 6                                | 3                 | 0.7071         |
| P1             | P7             | 45                               | 68                               | 39                | 0.705          |
| P8             | P5             | 33                               | 42                               | 26                | 0.6984         |
| P3             | P10            | 53                               | 54                               | 36                | 0.6729         |
| P9             | P11            | 22                               | 27                               | 16                | 0.6565         |
| P12            | P6             | 36                               | 41                               | 25                | 0.6507         |
| P2             | P4             | 44                               | 49                               | 30                | 0.6461         |
| P15            | P14            | 10                               | 6                                | 5                 | 0.6455         |

Note: ‘\*’ indicates the publication number/details listed in Table-5.

**Table 5: Top Ten Tightly Coupled Publications Details**

| Sl. No. | Title of the publication                                                                                                                                                             | Author(s)                                              |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| P1      | Enantioselective Enolate Protonation in Sulfa-Michael Addition to alpha-Substituted N-Acryloyloxazolidin-2-ones with Bifunctional Organocatalyst                                     | Rana NK; Singh VK                                      |
| P2      | A General Catalytic Route to Isoindolinones and Tetrahydroisoquinolines: Application in the Synthesis of (+/-)-Crispine A                                                            | Dhanasekaran S; Bisai V; Unhale RA; Suneja A; Singh VK |
| P3      | Asymmetric Alkynylation/Lactamization Cascade: An Expeditious Entry to Enantiomerically Enriched Isoindolinones                                                                      | Bisai V; Suneja A; Singh VK                            |
| P4      | Unified Approach to Isoindolinones and THIQs via Lewis Acid Catalyzed Domino Mukaiyama-Mannich Lactamization/Alkylations: Application in the Synthesis of (+/-)-Homolaudanosine      | Dhanasekaran S; Kayet A; Suneja A; Bisai V; Singh VK   |
| P5      | Total Synthesis of (+/-)-Taiwaniaquinol F and Related Taiwaniaquinoids                                                                                                               | Kakde BN; Kumari P; Bisai A                            |
| P6      | Ring closure dynamics for a chemically active polymer                                                                                                                                | Sarkar D; Thakur S; Tao YG; Kapral R                   |
| P7      | Organocatalytic enantioselective transient enolate protonation in conjugate addition of thioacetic acid to alpha-substituted N-acryloyloxazolidinones                                | Unhale RA; Rana NK; Singh VK                           |
| P8      | Metal triflate-catalyzed cyclization of arylvinylcarbinols: formal synthesis of (+/-)-dichroanone and (+/-)-taiwaniaquinone H                                                        | Kakde BN; De S; Dey D; Bisai A                         |
| P9      | Charge density waves condensate as measure of charge order and disorder in Eu <sub>1-x</sub> Sr <sub>x</sub> MnO <sub>3</sub> (x=0.50, 0.58) manganites                              | Pandey P; Awari N; Rana R; Singh A; Prabhu SS; Rana DS |
| P10     | Ni(II)-Catalyzed Highly Stereo- and Regioselective Syntheses of Isoindolinones and Isoquinolinones from in Situ Prepared Aldimines Triggered by Homoallylation/Lactamization Cascade | Karmakar R; Suneja A; Bisai V; Singh VK                |
| P11     | Charge-density wave condensate in charge-ordered manganites: impact of ferromagnetic order and spin-glass disorder                                                                   | Rana R; Awari N; Pandey P; Singh A; Prabhu SS; Rana DS |
| P12     | Dynamics of Loop Formation in Active Chains                                                                                                                                          | Sarkar D; Brahmanandan A; Thakur S                     |
| P13     | Composition Dependent Light Induced Crossover from Photodarkening to Photobleaching in GexAs35-xSe65 Thin Films                                                                      | Khan P; Adarsh KV                                      |
| P14     | Fractional Powers of Dehn Twists about Nonseparating Curves                                                                                                                          | Rajeevsarathy K                                        |
| P15     | Roots of Dehn Twists about Separating Curves                                                                                                                                         | Rajeevsarathy K                                        |
| P16     | Nanosecond Light Induced Transient Absorption in a-Ge5As30Se65 Thin Films                                                                                                            | Khan P; Sharma R; Adarsh KV                            |

## Cluster Analysis

*Keywords Plus* and *Author Keywords* are provided in Web of Science bibliographic database for helping users to broaden their searches. *Keywords Plus* is the result of Web of Science (Clarivate Analytics) editorial expertise where editors review the titles of all references and highlight additional relevant keywords that were not listed by the author or publisher,

whereas *Author Keywords* are the keywords given by the author in the publication itself.

The Table-6 list out the most top ten relevant and frequently occurred/used keywords (*Keywords Plus* and *Author Keywords*) in total 464 publications. The *Author Keyword* 'Optical Properties' and the *Keywords Plus* 'Derivatives' has occurred in 7 and 33 publications respectively.

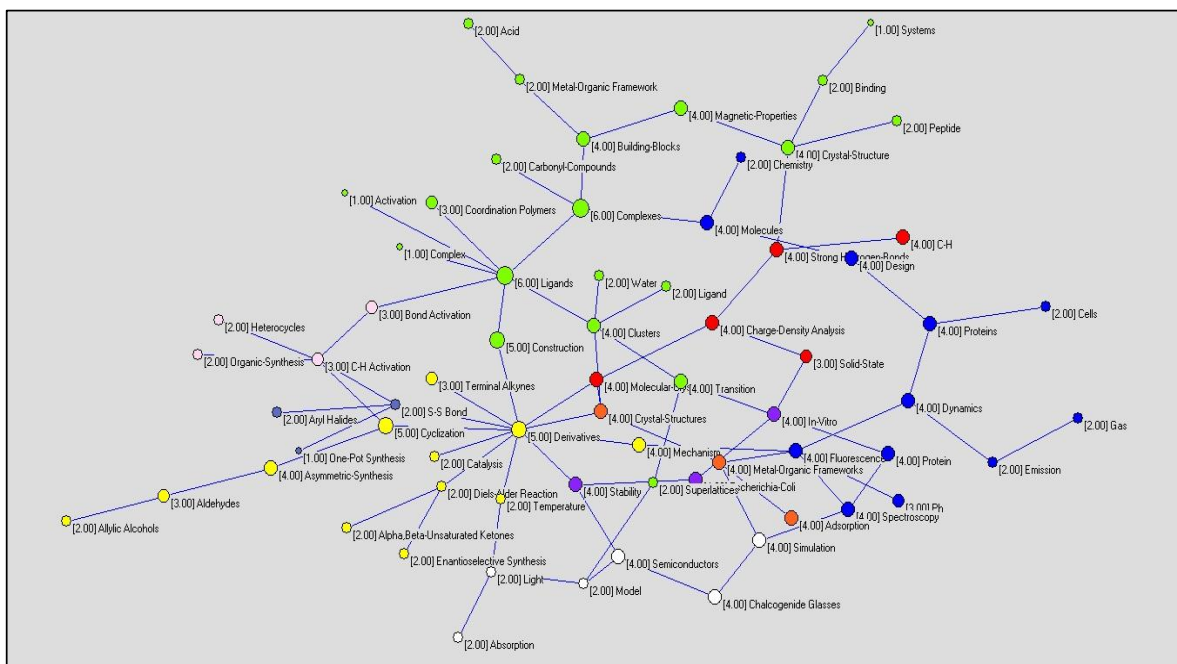
**Table 6: List of Most Relevant Keywords**

| Sl. No. | Author Keywords (DE) | Publications | Keywords-Plus (ID) | Publications |
|---------|----------------------|--------------|--------------------|--------------|
| 1       | Optical Properties   | 7            | Derivatives        | 33           |
| 2       | Chalcogenide Glasses | 6            | Complexes          | 21           |
| 3       | Fluorescence         | 6            | Clusters           | 16           |
| 4       | Thin Films           | 6            | Proteins           | 16           |

| Sl. No. | Author Keywords (DE) | Publications | Keywords-Plus (ID)       | Publications |
|---------|----------------------|--------------|--------------------------|--------------|
| 5       | Ebselen              | 5            | Crystal-Structure        | 15           |
| 6       | Galaxies: Ism        | 5            | Fluorescence             | 14           |
| 7       | Self-Assembly        | 5            | Stability                | 14           |
| 8       | Heterocycles         | 4            | Asymmetric-Synthesis     | 13           |
| 9       | Organocatalyst       | 4            | Ligands                  | 13           |
| 10      | Pixel                | 4            | Metal-Organic Frameworks | 13           |

Further, cluster analysis of keywords (*Keywords Plus - ID*) of total publications has been derived. There were 2313 unique keywords out of total 3729 keywords extracted. The

Graph-5 represents clustering network of 68 keywords; each of which occurred in more than 5 publications and that was the cut off.



**Graph 5: Keywords Clustering Network**

## International Collaboration

The Table 7 depicts international collaboration on the basis of first author's affiliation which reveals that 428 publications (92.24%) were from India, followed by 15 publications (3.23%) from USA, and the remaining 21 publications

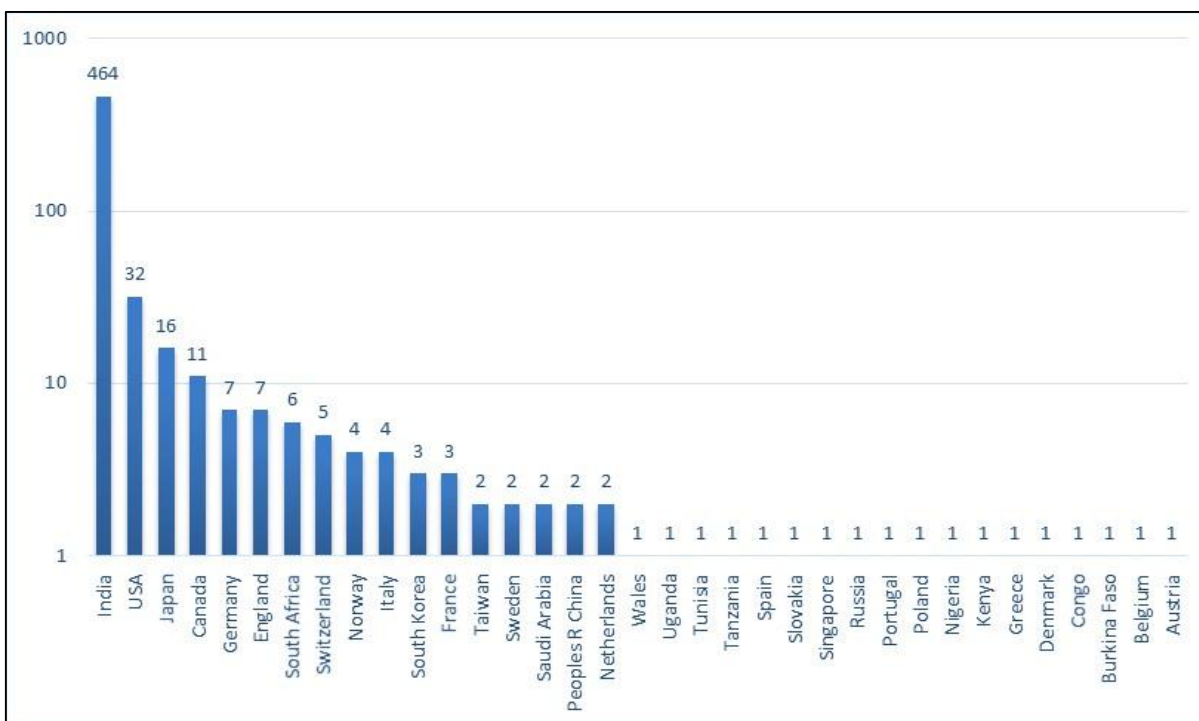
(4.53%) were from other 14 countries. Further, the Graph-6 represents the international collaboration on the basis of each author's affiliation.

USA, Japan, and Canada were the top three collaborative countries with India (IISER Bhopal) having 32, 16, and 11 collaborative publications respectively.

**Table 7: International Collaboration on the Basis of First Author's Affiliation**

| Country | Publications | Fraction of Share | Country      | Publications | Fraction of Share |
|---------|--------------|-------------------|--------------|--------------|-------------------|
| India   | 428          | 0.92241           | Germany      | 1            | 0.00216           |
| USA     | 15           | 0.03233           | Korea        | 1            | 0.00216           |
| Japan   | 3            | 0.00647           | Saudi Arabia | 1            | 0.00216           |
| Norway  | 3            | 0.00647           | Singapore    | 1            | 0.00216           |
| Italy   | 2            | 0.00431           | South Africa | 1            | 0.00216           |

| Country     | Publications | Fraction of Share | Country     | Publications | Fraction of Share |
|-------------|--------------|-------------------|-------------|--------------|-------------------|
| Netherlands | 2            | 0.00431           | Spain       | 1            | 0.00216           |
| Taiwan      | 2            | 0.00431           | Sweden      | 1            | 0.00216           |
| England     | 1            | 0.00216           | Switzerland | 1            | 0.00216           |



**Graph 6: International Collaboration on the Basis of Each Author's Affiliation**

## CONCLUSIONS

As mentioned above, the presented study explored the various bibliometrics parameters of publications of IISER Bhopal published during 2011-2015 which were indexed in Web of Science Core Collection. A total of 464 publications were indexed which were having a total of 6060 citations. The annual percentage publications growth rate was 51.72913, and the average citations per publication was 13.06. Those publications were contributed by a total of 832 unique authors with an average of 1.79 authors per publication. The collaboration index was 1.87. Kumar, S and Konar, S were the most productive authors from IISER Bhopal who had highest number of publications and h-index to their credit. From the result obtained, it can be assumed that the research related to Optical Properties are the most focused research field at the Institute. USA, Japan, and Canada were the three most collaborative countries with IISER Bhopal.

## REFERENCES

Solanki, T., Uddin, A., & Singh, V. K. (2016). Research competitiveness of Indian institutes of science education

and research. *Current Science*, 110(3), 307-310. Retrieved from <http://www.currentscience.ac.in/Volumes/110/03/0307.pdf>

Visakhi, P., Gupta, R., & Gupta, B. M. (2014). Contribution and Impact of IISERs: A Scientometric Assessment of Publications during 2010-14. *Library Philosophy and Practice (e-journal)*. 1352. Retrieved from <http://digitalcommons.unl.edu/libphilprac/1352>

Pathak, S. K. (2015). A scientometric study of research papers of IISER Bhopal (India) during 2009-2014. Retrieved from <https://pdfs.semanticscholar.org/af23/79add3e2bd1fa907e07a26e4f471a8c03ba.pdf>

<http://www.iisersystem.ac.in/>

<https://www.iiserb.ac.in/institute/visionMission>

[https://en.wikipedia.org/wiki/Indian\\_Institutes\\_of\\_Science\\_Education\\_and\\_Research](https://en.wikipedia.org/wiki/Indian_Institutes_of_Science_Education_and_Research)

[https://en.wikipedia.org/wiki/Bibliographic\\_coupling](https://en.wikipedia.org/wiki/Bibliographic_coupling)