



SCIENTOMETRIC DIMENSIONS OF CRYSTALLOGRAPHY RESEARCH IN INDIA: A STUDY BASED ON WEB OF SCIENCE DATABASE

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ABSTRACT

The present study deals a scientometric analysis of 7781 papers published in the Indian Crystallography research during the period 2006 to 2015. Data is collected using the Web of Science and analyzed using Microsoft Excel. The study focuses on various aspect of the Crystallography research such as growth of papers (year wise), most prolific authors, document types, institutions involved, international collaboration linkages. The highest number of articles was published in the year of 2011, while lowest numbers of articles were reported in the year 2015. Most of research publications are published in English language and most of the publications published in the form of research articles.

KEYWORDS: Scientometrics, Crystallography, Growth, Web of Science, Impact Factor, Collaboration.

INTRODUCTION:

There are numerous reasons and variety of purposes for which scientometric studies are undertaken. In the normal course, such

studies are undertaken to evaluate research output of a particular subject during the particular period and it help us to develop a scientific acumen towards the potential of research trend in a particular science. Publication of qualitative research results, type and kind of scientific community which may have contributed in publishing their research results in a particular journal, etc.

Most of the scientometric studies are undertaken to assess the research

productivity of an institution, organisation, publications of particular subject or field, research results published in a particular journal or any other similar activity which is confined to literature or research growth and its evaluation through quantitative techniques published during a particular period.

Scientometrics is a branch of the science 'Science of Science'. Haitun treats 'Scientometrics', as scientific disciplines, which performs reproducible measurements of scientific activity (Haitun, 1983). Now a day's scientometrics is one of the truly interdisciplinary research fields extended to almost all scientific fields. Scientometrics applications are used to measure scientific activities, mainly by producing statistics on



scientific publications indexed in databases.

CRYSTALLOGRAPHY

Crystallography is the experimental science of determining the arrangement of atoms in the crystalline solids (see crystal structure). The word "crystallography" derives from the Greek words *crystallon* "cold drop, frozen drop", with its meaning extending to all solids with some degree of transparency, and *grapho* "I write". In July 2012, the United Nations recognised the importance of the science of crystallography by proclaiming that 2014 would be the International Year of Crystallography. X-ray crystallography is used to determine the structure of large biomolecules such as proteins. Before the development of X-ray diffraction crystallography (see below), the study of crystals was based on physical measurements of their geometry. This involved measuring the angles of crystal faces relative to each other and to theoretical reference axes (crystallographic axes), and establishing the symmetry of the crystal in question. This physical measurement is carried out using a goniometer. The position in 3D space of each crystal face is plotted on a stereographic net such as a Wulff net or Lambert net. The pole to each face is plotted on the net. Each point is labelled with its Miller index. The final plot allows the symmetry of the crystal to be established.

WEB OF SCIENCE

Web of Science (previously known as (ISI) Web of Knowledge) is an online subscription-based scientific citation indexing service maintained by Thomson Reuters United States that provides a comprehensive citation search. It gives access to multiple databases that reference cross-disciplinary research, which allows for in-depth exploration of specialized sub-fields within an academic or scientific discipline. Records kept in Citation indexing, author, topic title, subject keywords, abstract, periodical title, author's address, publication year and it also format coverage full text articles, reviews, editorials, chronologies, abstracts, proceedings (journals and book-based), technical papers.

REVIEW OF LITERATURE

Mahapatra (1985) assessed the Relative Growth Rates (RGR) is a measure to study the increase in number of articles/pages per unit of articles/pages per unit of time. Gururaj S Hadagali and Gavisiddappa Anadhalli (2015) demonstrates the growth of neurology literature for the period 1961-2010. A total of 291,702 records were extracted from the Science Direct Database for fifty years. The Relative Growth Rate (RGR) and Doubling time (Dt.) of neurology literature have been calculated, supplementing with different growth patterns to check whether neurology literature fits exponential, or logistic model. Gavisiddappa Anadhalli (2014) an attempt has been made to test the validity of Lotka's law in the domain of library and information science (LIS) published in the LISTA database considers only the Authors of the Articles that appear in 2008 to 2012 as the base for the study which included 1012 articles contributed by 2022 authors. Lotka's law is one of the most basic laws of bibliometric and it deals with frequency of publication by authors in any given field. The study reveals three methods namely Sen's Method Pao's Method and Maximum Likelihood Method are used and tested and finally verified through Kolmogorov smirnov test. Finally it can be concluded that Lotka's law by and large holds good for the authorship pattern in the field of library and information science. Neelamma and Gavisiddappa Anadhalli (2015) identified with the help of Web of Science (WoS) the most of the research publications are published in English language and most of the publications published in the form of research articles; China is the highest contributor to the field of Crystallography.

NEED FOR THE STUDY

These applications are extremely valuable methods for evaluating research output, to know about the author productivity and citation analysis in science and technology. Scientometric tools can be used to measure and describe countries, universities, research institutes, journals, specific research topics and specific disciplines. This paper focuses on quantitative study of Indian Crystallography research by applying simple scientometric techniques.

OBJECTIVES

The specific objectives of this study is to analyze the research performance of India in Crystallography research in national and global context, as reflected in web of science database during 2006 to 2015. In particular, the study focuses on the following objectives:

- 1.To identify and analyse the year-wise growth of research;
- 2.To study the document type of the articles;
3. To identified subject wise growth of publications;
- 4.To identify the highly productive journals;
- 5.Pattern of communication of Indian output in most productive journals;
- 6.To assess the institution wise research concentration; and
- 7.To identify country wise collaborative distribution of publications and high cited-papers.

METHODS AND MATERIALS USED

This study is based on the publications output as indexed by Web of Science database for the period 2006 to 2015. The study uses 10 years publications data on Indian Crystallography from Web of Science database. The growth rate of output in terms of research productivity is analyzed. The subject-wise research performance is analyzed to identify hot area of research.

RESULTS AND DISCUSSION

One of the obvious features of scientific literature in recent years has been its rate of growth. A number of growth models have been proposed regarding the rate of growth. Price (1963) proposed an exponential rate of growth of scientific literature. He predicted a regular exponential growth with doubling period of ten to fifteen years.

Table 1 depicts the crystallography research output of India, India has produced 7781 publications. As per the web of science data, cumulative publications growth, the output of India The highest number of articles 1074(13.8) was published in the year of 2011, While lowest number of research articles was published 584 (7.5) in the year 2015.

Table 1: Year-wise growth and development of Indian Crystallography research

Sl. No	Years	No of Records	% of Records	Cumulative Records	Cumulative % of Records
1	2006	747	9.6	747	9.6
2	2007	967	12.4	1714	22.028
3	2008	756	9.7	2470	31.743
4	2009	888	11.4	3358	43.156
5	2010	895	11.5	4253	54.658
6	2011	1074	13.8	5327	68.461
7	2012	617	7.9	5944	76.391
8	2013	609	7.8	6553	84.217
9	2014	644	8.3	7197	92.494
10	2015	584	7.5	7781	100
		7781	100%		

Table 2 deals with the document wise distribution of Indian Crystallography research during the period of 2006 to 2015. A total of 7781 records were published, out of which most of the records in crystallography are published in the form of research articles 77541 (96.92). The remaining records are published in other forms like proceeding papers 145 (1.864), Review 35 (0.45), Correction 29 (0.373), Editorial Material 22 (0.283), Software Review 7 (0.09) and Letters 2 (0.026).

Table 2: Bibliographical form wise of Research Publications

Sl. No.	Document Types	Records	Percentage	Cum. %
1	Article	7541	96.916	96.916
2	Proceedings Paper	145	1.864	98.780
3	Review	35	0.450	99.229
4	Correction	29	0.373	99.602
5	Editorial Material	22	0.283	99.885
6	Software Review	7	0.090	99.975
7	Letter	2	0.026	100

Research output under various subjects

The crystallography publications further grouped based on subject wise are identified and the same in Table 3. Highest number of publications (> 1000) contributed to 2 domains: Chemistry (2777) and Materials Science (1417). The top two subject fields receive 53.90% of the country's publications in the field of crystallography. Hence, most of the crystallography applications can be seen in Chemistry, Materials Science, Physics and Biochemistry Molecular Biology. The application has also into other disciplines too.

Table 3: Research output under various subjects

Sl. No.	Sub-fields	Records	Percentage	Cum. %
1	Chemistry	2777	45.27	45.27
2	Materials Science	1417	23.10	68.37
3	Physics	723	11.79	80.16
4	Biochemistry Molecular Biology	432	7.04	87.20
5	Biophysics	285	4.65	91.85
6	Spectroscopy	206	3.36	95.20
7	Mathematical Computational Biology	147	2.40	97.60
8	Computer Science	147	2.40	100
	Total	6134	100	

Indian institutional contribution in the field of crystallography

Based on the publications output for India in crystallography, total of 10 institutions were identified as high productive between 201 and 1068 publications, with an average output 441 publication per institution during 2006 to 2015. These top 10 institutions together contributed 4,412 publications total research output by India in crystallography.

Institutions along with their publications outputs are: Mangalore University has published highest number of articles i.e. 1068 (publications with 24.21%), followed by University of Mysore 561 publications (12.72%), Indian Institute of Science 545 publications (12.35%), Indian Institute of Technology 527 publications (11.94%), University of Madras 506 publications (11.47%), Jadavpur University 331 publications (7.50%), Anna University 234 publications (5.30%) and University of Hyderabad has published 233 publications with 5.28%. (Table 4).

Table 4: Indian institutional contribution in the field of crystallography

Sl. No.	Organizations	records	% of 7781
1	Mangalore University	1068	24.21
2	University of Mysore	561	12.72
3	Indian Institute of Science	545	12.35
4	Indian Institute of Technology	527	11.94
5	University of Madras	506	11.47
6	Jadavpur University	331	7.50
7	Anna University	234	5.30
8	University of Hyderabad	233	5.28
9	Indian Association of Cultivation Science	206	4.67
10	Indian Institute of Chemical Technology	201	4.56
	Total	4412	100

Impact of journals of Indian contributions with more than 200 publications

Further impact of journals of Indian contributions with more than 200 publications in crystallography has been in the table 5 the impact factor is one of these; it is a measure of the frequency with which the “average article” in journal has been cited in a given period of time. The impact factor for a journal is calculated based on a 3 years period, and can be the average number of times published papers are cited up to 2 years after publication.

Based on the records the Acta Crystallographica Section E Structure Reports Online holds the first position (2750 articles), followed by Polyhedron (979 articles), Crystal Growth Design (633 articles), Crystengcomm (499 articles), Journal of Crystal Growth (480 articles), Molecular Crystals and Liquid Crystals (422 articles), Crystal Research and Technology (331 articles), Liquid Crystals (245 articles), Phase Transitions (243 articles) and Journal of Chemical Crystallography (206 articles).

Table 5: Impact of journals of Indian contributions with more than 100 publications

Sl. No.	Source Titles	Records	Percentage
1	Acta Crystallographica Section E Structure Reports Online	2750	40.51
2	Polyhedron	979	14.42
3	Crystal Growth Design	633	9.33
4	Crystengcomm	499	7.35
5	Journal of Crystal Growth	480	7.07
6	Molecular Crystals and Liquid Crystals	422	6.22
7	Crystal Research and Technology	331	4.88
8	Liquid Crystals	245	3.61
9	Phase Transitions	243	3.58
10	Journal of Chemical Crystallography	206	3.03
	Total	6788	100

International collaboration

Collaboration has become a well-established feature in the field of crystallography. It is observed that there is a consistently increasing trend towards collaboration among various branches of crystallography which leads to collaborative authorship in literature.

Table 6 depicts the international collaborative papers of India with top 10 countries during 2006 to 2015. The share international publications in the Indian crystallography research output was among the different collaborative countries the Malaysia ranked first with 669 publications and 23.48% of total output, Germany which ranked second with 658 publications, United States ranked third with 609 publications, followed by

England 183 publications, Spain 155 publications, Japan 138 publications, South Korea 133 publications, Scotland 109 publications, Italy 100 publications and Poland 95 publications (Table 6).

Table 6: International Collaboration

Sl. No.	Countries/Territories	Records	Percentage
1	Malaysia	669	23.48
2	Germany	658	23.10
3	USA	609	21.38
4	England	183	6.42
5	Spain	155	5.44
6	Japan	138	4.84
7	South Korea	133	4.67
8	Scotland	109	3.83
9	Italy	100	3.51
10	Poland	95	3.33
	Total	2849	100

CONCLUSION

It is important to evaluate the research performance of major crystallography research of the country and to compare their performance among themselves and similar institutes of other countries. The present study analyses the growth of literature published by the researchers in India for 2006 to 2015 as reflected in Web of Science (WoS) database. India has produced 7,781 publications during the period. This study presented a summary of scientometric research in the crystallographic area. Using publication of literature, an overview of scientometric efforts have been presented to trace the emergence of this new technological area. The paper has also presented data that gives an idea about which countries are the most active in terms of scientific publications in crystallography. Finally it is concluded that the result of a scientometric study that focuses on the field of crystallography and the collaboration among authors, institutions and countries of Indian crystallography literature has been gradually increased year by year.

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