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RESEARCH OUTPUT OF INDIA IN SPECTROSCOPY DURING 2000-2014: A SCIENTOMETRICS STUDY

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Short Profile

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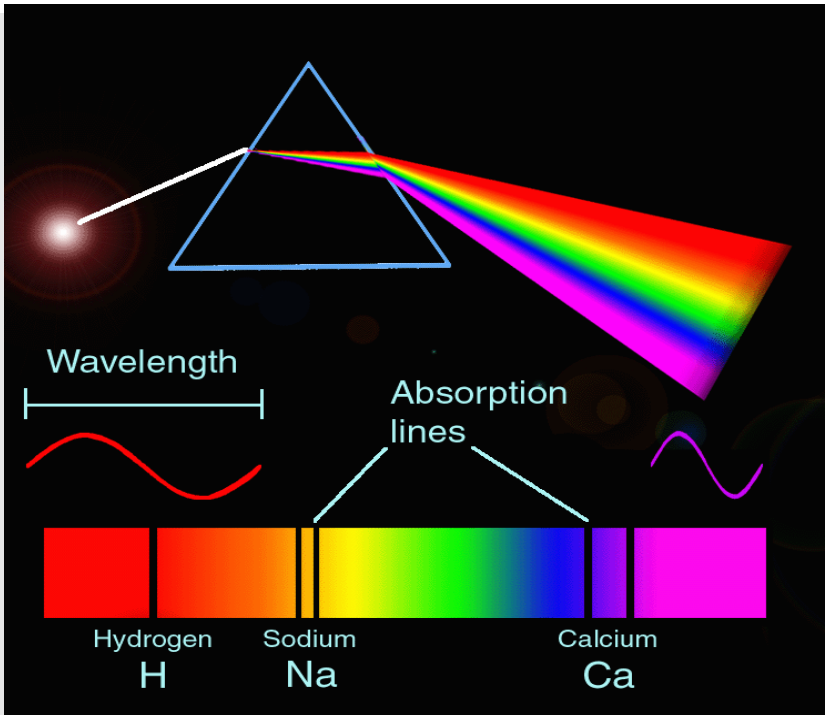

ABSTRACT:
This paper attempts to highlight the growth and development of spectros copy research work in India during 2000-2014 as per Web of Science database. Data was coded and tabulated with the help of various scientometrics techniques. Total numbers of 5519 publications were published and 46625 citations were received while average citations per paper were 12.46 and h-index is 59. The parameters studied include: year-wise growth of publications and citations, document type-wise distributions of publications and citations, subject-wise distributions of publications and citations, researchers contributions of publications, contributions of publications in Indian institutions, International collaborations wise distributions of publications, highly preferred journals for publications by the scientists and highly cited papers.

KEYWORDS
Scientometics, Spectroscopy, Citations, Web of Science, International Collaboration.

INTRODUCTION

India is one of the largest economies in the world today and it is continue to grow rapidly. India's growth has positive impact on the research activity especially in the field of science and technology as government is providing huge funds to research institutions, universities to the research endeavor. Many institutions like CSIR, BARC, IIT's and IISc are doing many pioneering work in the field of science and technology, these are the leading institutions in India as well as in the world.

Spectroscopy is study of the absorption and emission of light and other radiation by matter, as related to the dependence of these processes on the wavelength of the radiation. More recently, the definition has been expanded to include the study of the interactions between particles such as electrons, protons, and ions, as well as their interaction with other particles as a function of their collision energy. Evolution of spectroscopy goes back to Isaac Newton's optics experiments (1666–1672). Newton applied the word "spectrum" to describe the rainbow of colors that combine to form white light and that are revealed when the white light is passed through a prism. During the early 1800s, Joseph von Fraunhofer made experimental advances with dispersive spectrometers that enabled spectroscopy to become a more precise and quantitative scientific technique. Since then, spectroscopy has played and continues to play a significant role in chemistry, physics and astronomy. In India there are many research works are taking place in spectroscopy.

Scintometrics is "Quantitative study of science, communication in science and science policy'' scientometrics is discipline which portrait structure of science and its dimensions. It investigates the scientific publications and citations appended to the publications and to make out countries performance in particular subject, performance of institutions as well as individuals.

NEED FOR THE STUDY:

Growth in any domain today is rapid and it is very big problem to keep updated with resent development. Scientometric studies like this will help researchers to get updated with latest happenings in their respected domains and it also brings out Indian research performance and its contribution in spectroscopy to the world.

OBJECTIVES OF THE STUDY:

The foremost objective of the study is to carry out scientometrics analyses of all spectroscopy research publications of India. The parameters studied consists of

1. Year- wise Growth and distribution of publications and citations;
2. Document type-wise distribution of publications and citations;
3. Researcher's contribution of India and their citations;
4. Subjects-wise distribution of publications and citations;
5. Institutions contributions of articles and citations;
6. Journals preferred for publications by researchers;
7. International collaborations of publications and citations;
8. Highly cited papers in the field of spectroscopy.

METHODOLOGY:

For the present study "Research Output of India in Spectroscopy during 2000-2014: A Scientometric Study" web of Science data base has been used. Study limits 2000-2014. Web of Science is online subscription based citation indexing service maintained by ISI Thompson Reuters. The publications, citations, H-index of 15 years (2000-2014) has been taken for the study and status and progress of spectroscopy research in India has been discussed.

RESULTS AND DISCUSSION:

Year Wise Growth and Distributions of Publications and Citations

Table 1 shows that India has contributed total number of 5519 publications on spectroscopy as per web of science database during 2000-2014 and these publications received total 46625 citations with 59 h-indexes. Highest publications (864) were published in the year 2014 but same year received lowest citations (899). In the year 2002 lowest 131 publications were published and received 2416 citations whereas highest citations were received in the year of 2003 i.e. 7702 (52.04 ACP) citations for 148 publications during 2000-2014. Average publications per year were 367.33, average citations per year were 3108.33, and average citation per paper was 12.46. It is observed that older publications received more citations than recent publications.

Table 1: Year Wise Growth and Distributions of Publications and Citations

Years	TP	TC	ACP	H-Index	Percentage (%)
2000	138	1599	11.59	23	2.50
2001	142	1693	11.92	22	2.57
2002	131	2416	18.44	21	2.37
2003	148	7702	52.04	23	2.68
2004	199	2547	12.8	25	3.61
2005	269	3692	13.72	30	4.87
2006	284	3910	13.77	29	5.15
2007	305	3281	10.76	25	5.53
2008	400	3910	9.77	27	7.25
2009	378	3748	9.92	27	6.85
2010	403	3123	7.75	24	7.30
2011	546	3371	6.17	22	9.89
2012	647	2898	4.48	18	11.72
2013	665	1836	2.76	11	12.05
2014	864	899	1.04	9	15.66
Total	**5519**	**46625**	**12.46**	**59**	**100**

TP= Total Publications, TC= Total Citations, ACP= Average Citations per Publications

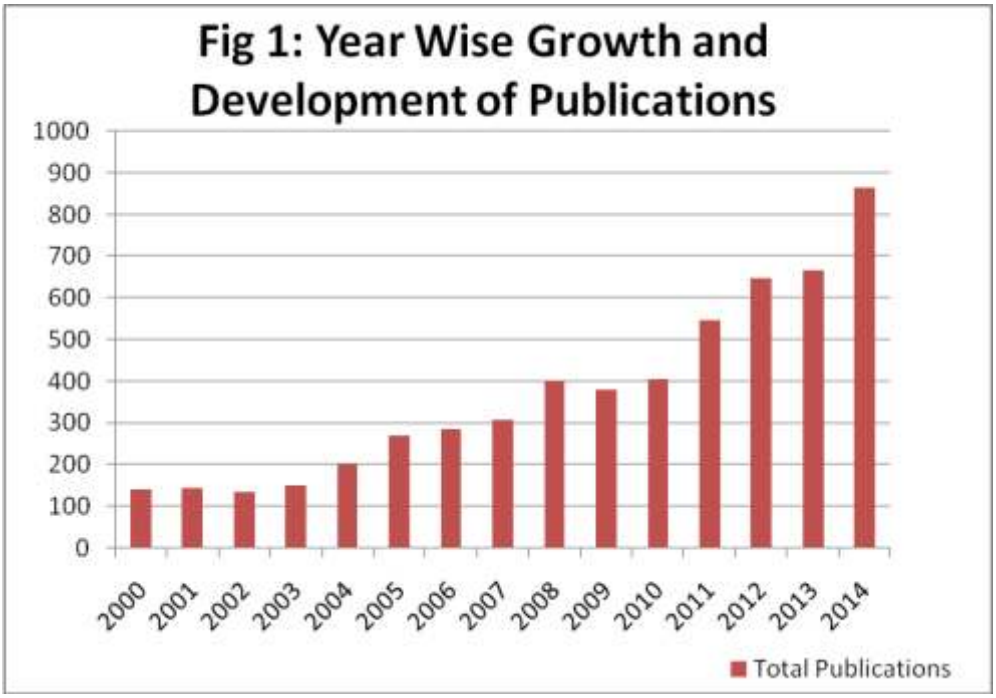

Fig 1: Year Wise Growth and Development of Publications

Document Type-Wise Distribution of Publications and Citations

Table 2 gives an idea about publications which published in different type of documents during 2000-2014. Articles has highest share with 5118 (92.73%) publications followed by proceeding papers 301 (5.45%) while reviews are having share of 41 (0.74) whereas reprints has only one publication (0.02%) in terms of citation received articles (38693), proceedings papers (1158), reviews (6585). It is observed that reviews are having highest ACP (156.79).

Table 2: Document Type-Wise Distribution of Publications and Citations

Types	TP	TC	ACP	H-Index	Percentage
Articles	5118	38693	7.57	58	92.73
Proceeding Papers	301	1158	3.72	16	5.45
Review	41	6585	156.79	15	0.74
Letter	28	107	3.82	6	0.51
Correction	13	4	0.31	1	0.24
Book Chapter	9	64	7.11	3	0.16
Editorial Material	8	10	1.25	2	0.14
Reprint	1	4	4	1	0.02
Total	**5519**	**46625**	**12.46**	**59**	**100**

TP= Total Publications, TC= Total Citations, ACP= Average Citations per Publications

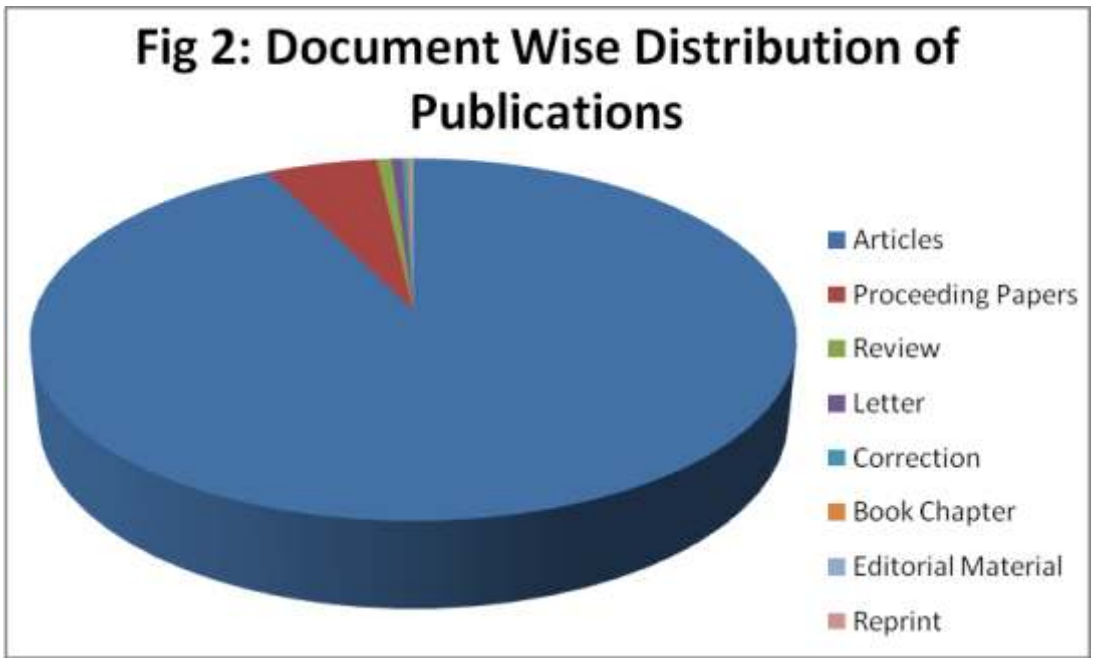

Fig 2: Document Type-Wise Distribution of Publications

Top Scientists/Researchers Contributions

Table 3 shows highly productive scientists/researchers of India in the field of spectroscopy based on their publications and also on citations during 2000-2014. After analyzing data it is found that Kumar, A has highest publications to his credit (101) followed by Krishnakumar, V with 91 publications whereas Sundarganesan, N is having 89 publications. In terms of citations received Sundarganesan, N is highly cited with 1623 citations amongst all he is having highest H- Index as well, where as Krishankumar, V is having 1330 citations.

Table 3: Top Scientists/Researchers Contributions

Sl. No.	Authors	TP	TC	ACP	H-Index
1	Kumar A	101	1286	12.73	15
2	Krishnakumar V	91	1330	14.62	21
3	Sundaraganesan N	89	1623	18.24	25
4	Bhattacharya S	88	522	5.93	13
5	Joe IH	81	1236	15.26	17
6	Mohan S	76	891	11.72	17
7	Chandra S	76	1203	15.83	21
8	Panicker CY	75	796	10.61	16
9	Ramakrishnan V	64	554	8.66	14
10	Jayabharathi J	62	403	6.5	10

TP= Total Publications, TC= Total Citations, ACP= Average Citations per Publications

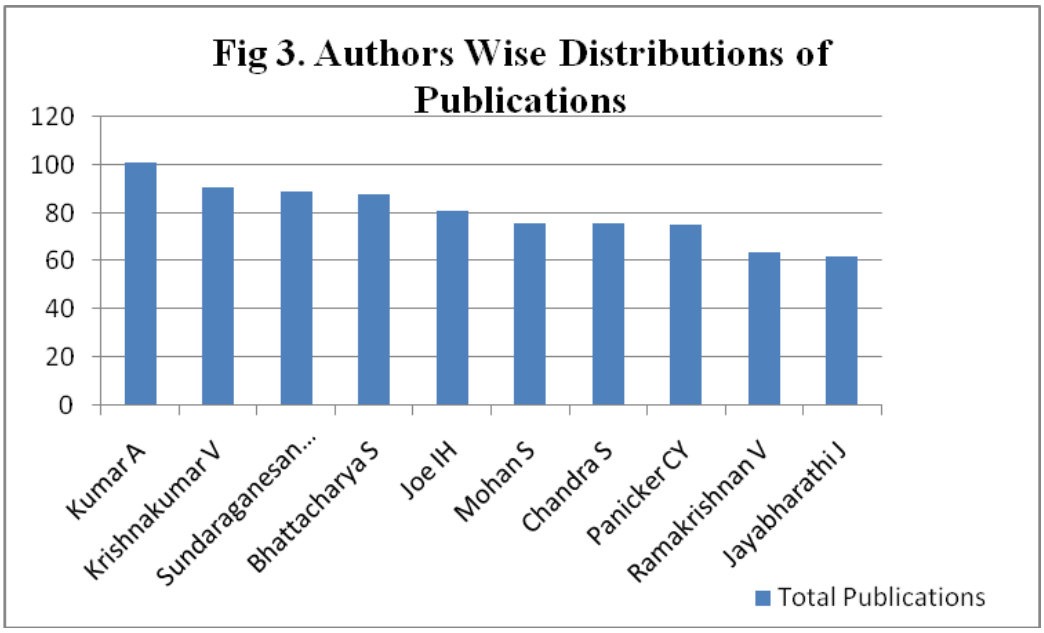

Fig 3: Authors Wise Distributions of Publications

Subjects-Wise Distribution of Publications and Citations

Table 4 show subject-wise distributions of publications on spectroscopy published during 2000-2014 according to web of science database. As all ready discussed spectroscopy is playing significant role in many other domains like physics, chemistry and many more. Physics top the list with 830 publications and it is also received highest citations i.e. 12462; chemistry is having 754 publications and received 4741 citations. In terms of average citations per publications nuclear science technology received highest 24.57 ACP.

Table 4: Subjects-Wise Distribution of Publications and Citations

Sl. No.	Subjects	TP	TC	ACP	H-Index
1	Physics	830	12462	15.01	30
2	Chemistry	754	4741	6.29	26
3	Instruments Instrumentation	477	10791	22.62	28
4	Nuclear Science Technology	426	10465	24.57	27
5	Crystallography	261	663	2.54	10
6	Food Science and Technology	243	691	2.84	10
7	Biochemistry Molecular Biology	237	1480	6.24	17
8	Biophysics	82	806	9.83	17
9	Optics	52	52	1	5
10	Radiology Nuclear Medicine Medical Imaging	43	535	12.44	14

TP= Total Publications, TC= Total Citations, ACP= Average Citations per Publications

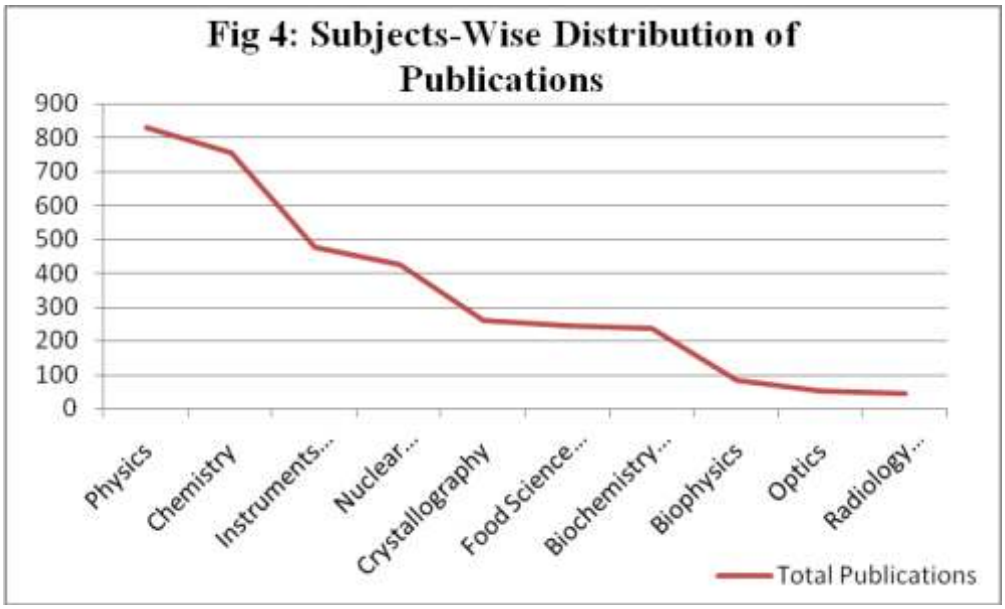

Fig 4: Subjects-Wise Distribution of Publications

Journals-Wise Distribution of Publications and Citations

Journals are main source for publishing research work. Table 5 shows top 10 journals which published papers on spectroscopy during 2000-2014 as per web of science data base. Some journals are: Spectrochimica ACTA Part A Molecular and Biomolecular Spectroscopy 2617 publications, Nuclear Instruments Methods in Physics Research Section A Accelerators Spectrometers Detectors and Associated Equipment 426 publications, Journal of Chemical Crystallography 261 publications. Whereas in terms of total citations Spectrochimica ACTA Part A Molecular and Biomolecular Spectroscopy top the list with 22415 and in terms Average citations per paper Nuclear Instruments Methods in Physics Research Section A Accelerators Spectrometers Detectors and Associated Equipment highest with 24.57.

Table 5: Journals-Wise Distribution of Publications and Citations

Sl. No.	Sources	TP	TC	ACP	H-Index
1	Spectrochimica ACTA Part A Molecular and Biomolecular Spectroscopy	2617	22415	8.57	49
2	Nuclear Instruments Methods in Physics Research Section A Accelerators Spectrometers Detectors and Associated Equipment	426	10465	24.57	27
3	Journal of Chemical Crystallography	261	663	2.54	10
4	Analytical Methods	243	691	2.84	10
5	Journal of Raman Spectroscopy	221	2751	12.45	25
6	Journal of Quantitative Spectroscopy Radiative Transfer	151	775	5.13	15
7	Rapid Communications in Mass Spectrometry	137	1022	7.46	17
8	Atomic Spectroscopy	135	488	3.61	9
9	International Journal of Mass Spectrometry	100	640	6.4	14
10	Magnetic Resonance in Chemistry	98	533	5.44	11

TP= Total Publications, TC= Total Citations, ACP= Average Citations per Publications

Institution-Wise Distribution of Publications and Citations

The table 6 brings out the top institutions-wise distribution of publications in the journal during 2000-2014. These top institutions have contributed total 5519 publications together, with 46625 total citations. Council of Scientific Industrial Research (CSIR), India top the list with 515 publications and 3082 citations, followed by Bhabha Atomic Research Center with 498 publications and 2553 citations, while Annamalai University having 312 publications and 2956 citations.

Table 6: Institution-Wise Distribution of Publications and Citations

Sl. No.	Institutions	TP	TC	ACP	H-Index
1	Council of Scientific Industrial Research CSIR India	515	3082	5.98	22
2	Bhabha Atomic Research Center	498	2553	5.13	18
3	Annamalai University	312	2956	9.47	27
4	Indian Institute of Technology IIT	267	1766	6.61	19
5	Indian Institute of Science Iisc Banglore	215	1490	6.93	17
6	Banaras Hindu University	190	1909	10.05	20
7	Tata Institute of Fundamental Research	169	7573	44.81	21
8	University of Delhi	168	1812	10.79	25
9	Indian Institute of Chemical Technology	144	724	5.03	12
10	MAR Ivanios Coll	138	2426	17.58	27

TP= Total Publications, TC= Total Citations, ACP= Average Citations per Publications

International Collaborations

Research works today carried out through international collaboration, India has also collaborated with many countries table 7 shows top countries with which India has collaborated most in the area spectroscopy during 2000-2014. India has maximum collaborated with USA with 217 publications and received 9660 citations, followed by Germany with 146 publications and 9169 citations whereas Turkey has collaborated in 92 publications with India.

Table 7: International Collaboration

Sl. No.	Countries	TP	TC	ACP	H-Index
1	USA	217	9660	44.52	27
2	Germany	146	9169	62.8	24
3	Turkey	92	798	8.67	16
4	Japan	91	7941	87.26	19
5	France	89	7744	87.01	22
6	England	83	6932	83.52	17
7	South Korea	72	2125	29.51	13
8	Spain	69	6639	96.22	17
9	Italy	67	6431	95.99	14
10	Poland	62	2130	34.35	11

TP= Total Publications, TC= Total Citations, ACP= Average Citations per Publications

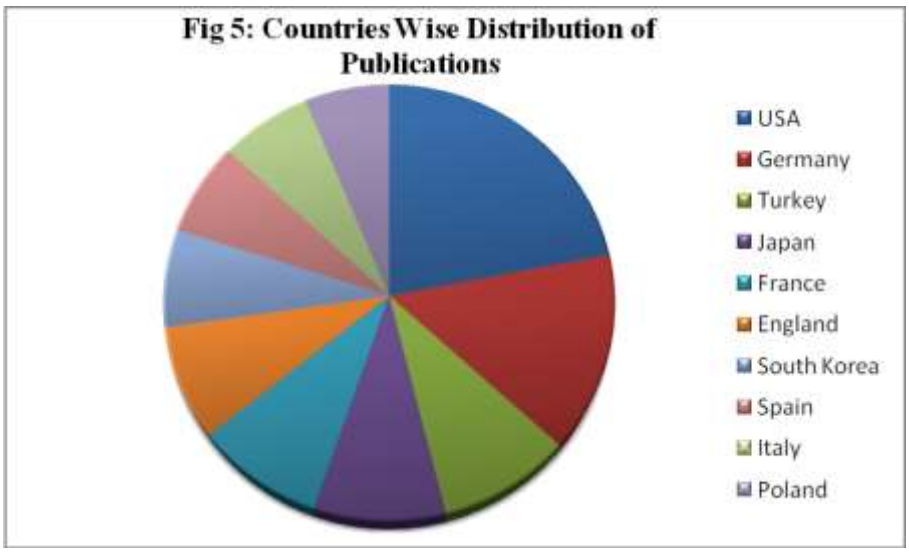

Fig 5: Countries Wise Distribution of Publications

Highly Cited Papers from India in Spectroscopy

Table 8 depicts highly Cited papers from India in spectroscopy published in various journals during 2000-2014. Most frequently cited one was GEANT4-a simulation toolkit with 5540 citations written by Agostinelli, S; Allison, J; Amako, K; et al which published in Nuclear Instruments & Methods in Physics Research Section A-Accelerators Spectrometers Detectors and Associated Equipment (2003). It is noted that 9 out of 10 papers were written by more than three authors and most of papers were published in Nuclear Instruments & Methods in Physics Research Section A-Accelerators Spectrometers Detectors and Associated Equipment.

Table 8: Highly Cited Papers from India in Spectroscopy

Sl. No.	Citations	Title	Authors	Source	Vol. No.	Iss. No.	Year
1	5540	GEANT4-a simulation toolkit	Agostinelli, S; Allison, J; Amako, K; et al	Nuclear Instruments & Methods In Physics Research Section A-Accelerators Spectrometers Detectors And Associated Equipment	506	3	2003
2	860	The Belle detector	Abashian, A; Abe, K; Abe, R; et al.	Nuclear Instruments & Methods In Physics Research Section A-Accelerators Spectrometers Detectors And Associated Equipment	479	1	2002
3	417	The upgraded DO detector	Abazov, V. M.; Abbott, B.; Abolins, M.; et al.	Nuclear Instruments & Methods In Physics Research Section A-Accelerators Spectrometers Detectors And Associated Equipment	565	2	2006
4	322	PHENIX detector overview	Adcox, K; Adler, SS; Aizama, M; et al.	Nuclear Instruments & Methods In Physics Research Section A-Accelerators Spectrometers Detectors And Associated Equipment	499	2-3	2003

5	237	The COMPASS experiment at CERN	Abbon, P.; Albrecht, E.; Alexakhin, V. Yu.; et al	Nuclear Instruments & Methods In Physics Research Section A-Accelerators Spectrometers Detectors And Associated Equipment	577	3	2007
6	219	Detector description and performance for the first coincidence observations between LIGO and GEO	Abbott, B; Abbott, R; Adhikari, R; et al.	Nuclear Instruments & Methods In Physics Research Section A-Accelerators Spectrometers Detectors And Associated Equipment	517	1-3	2004
7	178	FT Raman and FT IR spectra, vibrational assignments and density functional studies of 5-bromo-2-nitropyridine	Sundaraganesan, N; Ilakiamani, S; Saleem, H; et al.	Spectrochimica Acta Part A-Molecular And Biomolecular Spectroscopy	61	13-14	2005
8	165	Structural conformation and vibrational spectroscopic studies of 2,6-bis(p-N,N-dimethyl benzylidene) cyclohexanone using density functional theory	James, C.; Raj, A. Amal; Reghunathan, R.; et al	Journal Of Raman Spectroscopy	37	12	2006
9	159	Biosynthesis of Au, Ag and Au-Ag nanoparticles using edible mushroom extract	Philip, Daizy	Spectrochimica Acta Part A-Molecular And Biomolecular Spectroscopy	73	2	2009
10	132	Raman spectroscopy of optical phonon confinement in nanostructured materials	Arora, Akhilesh K.; Rajalakshmi, M.; Ravindran, T. R.; et al.	Journal Of Raman Spectroscopy	38	6	2007

CONCLUSION:

Spectroscopy plays a revolutionary part in physics, chemistry, Astronomy and nuclear science. Present study is an overview of spectroscopy research in India during 2000-2014. For analyzing gathered data many scientometric techniques has been used. Assessment of research activity is very important to get knowledge of present situation in that particular field.

After analyzing total number of 5519 publications and 46625 citations as indexed in Web of Science database during 2000-2014. The results show that there is significant growth in spectroscopy literature published from India. It may be researchers, institutions or India's collaborations with other countries, in all aspects considerable growth can be observed.

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