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Analysis of physics research output of SP Pune University during the period 1990-2014

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The paper analyzes the research contributions by the faculty members of the Department of Physics, Savitribai Phule Pune University (SPPU), Pune, Maharashtra, India for the period 1990-2014. Bibliographic and citation data were retrieved from Scopus database. Query statements covering all variations in the name of SPPU were used to search the database. Scopus indexed 1629 publications with 22618 citations for the period. Author keywords in Scopus database indicate that faculty members are working in core areas of physics as well as interdisciplinary subjects like chemistry, instrumentation sciences, engineering, etc. The year-wise analysis shows that research productivity of faculty member increased over the period. Faculty members published their research in core physics journals among which *Journal of Applied Physics* (72 papers) is the most preferred journal. The faculty members of the University have collaborated with scientists from USA, UK, Germany and Japan. At the national level, the University physicists have collaborated most with Bhabha Atomic Research Centre.

Keywords: Bibliometrics; Citation analysis; Physics; Network analysis, SP Pune University, Scopus

Introduction

Since last two decades, several bibliometric studies have been conducted to measure the research productivity of authors, institutions, countries, and to study research trends in specific subjects. For measuring the research productivity, bibliometricians and scientometricians have used various parameters to measure the research viz., citation counts, h-index[1], impact factor of the journal, national and international collaborations, number of papers, etc. Additionally, h-index, g-index[2], Google Scholar's i10 index, etc., are also in use.

In this study, bibliometric parameters are used to measure research contributions of physicists of Savitribai Phule Pune University (SPPU) (http://unipune.ac.in), India for the period 1990-2014. Specifically, this paper aims at identifying year-wise productivity, types of publications, national and international collaborations, journals preferred, research areas, authorship pattern, etc. The Department of Physics of SPPU was set up in 1952. The department today conducts research in areas like materials science, solid state physics, condensed matter physics, nonlinear dynamics, scanning tunneling microscopy, cloud physics, thin/thick films, diamond coatings, nuclear and accelerator physics, lasers, plasma physics, field electron/ion microscopy, biophysics etc. The Department conducts high quality post-graduate and doctoral programs and has flexibility in framing courses and conducting tests and examinations. The faculty members regularly conduct various extension programs for students and the general public. The department receives funds from Department of Science and Technology, Government of India under the Fund for Improvement of S&T infrastructure in universities & higher educational institutions (FIST) program. More than 43 faculty members are actively participating in research and teaching (http://www.unipune.ac.in/dept/science/physics/default.htm). In the present study, the research contributions of the department during last 25 years (1990-2014) has been analyzed.

Review of literature

There are a large number of studies found in literature on measuring the research contributions of a

particular country, university and individual departments as well as in a particular subject. In these studies, researchers have either used Web of Science or Scopus databases or both[3-6]. Worldwide, many studies have been conducted on measuring the research output of physicists. Zheng *et al* analyzed physics literature for the period 1979-2008 and revealed that USA and Japan are the two top countries in terms of quantity of physics research output produced[7]. There are other studies wherein citation databases viz., Web of Science, Scopus and Google Scholar were used and compared to measure the contributions of physicists[8-10]. Reyes *et al* used co-authorship and citation analysis to identify research groups in physics, applied physics, and optics[11].

Gopikuttan and Awasthy[12] studied the research productivity of Kerala University and Sudhier[13] studied research output of physicists of the same university. The results of these studies indicated that chemistry, physics, astronomy and astrophysics are the leading areas of research. Many researchers have evaluated the research outputs of the Indian Institutes of Technology (IITs). Chaurasia and Chavan[14] carried out a study for IIT Delhi for the period 2001-2010; Mishra and Sarangi[15] for IITs and National Institutes of Technologies (NITs), Singh *et al* for IIT, Rourkela for the period 1993-2001 and IIT Kharagpur for the period 1994-1997, Upadhye *et al* studied the contributions by nuclear physics division of Bhabha Atomic Research Center (BARC)[16-18].

The studies reviewed have analyzed author productivity, areas of specialization, publication pattern, authorship patterns, most prolific authors and preferred journals by authors for publishing. Datasets used in all these studies were from Web of Science or Scopus or both. Many of these studies were conducted during the period 1996-2014 and the results of these studies indicate that there is a steady growth in publications and citations received. The studies also identified strong and weak areas of research as well as national and international collaborations of researchers.

Objectives of the study

- To measure the research contributions quantitatively based on various bibliometric parameters viz., citations received, year-wise productivity, types of publications, etc.;
- To map international, national and local collaborations of faculty members;
- To study active research areas based on keywords analysis;
- To identify journals preferred by faculty members; and
- To study authorship pattern.

Methodology

For the present study, papers published by physicists of SPPU during 1990-2014 (25 years) indexed in Scopus database were selected. All publications including research papers, editorials, conference papers, etc., were considered for analysis as these have received citations. Contributions by individual authors are not considered as the objective is not to rank faculty members. For journal ranking, Impact Factor(IF) published in Journal Citation Report by Thomson Reuters and Journal Quartile as per Scimago were considered. Microsoft Excel, VosViewer and Pajek software tools were used for data analysis. KWIC Concordance software (http://www.chs.nihon-u.ac.jp/eng_dpt/tukamoto/kw-ic_e.html) was used to measure the keyword frequencies. N-gram tool provided in KWIC was used. An n-gram is a contiguous sequence of 'n' items from a given sequence of text or speech. The items can be phonemes, syllables, letters, words or base pairs according to the application (https://en.wiki-pedia.org/wiki/N-gram).

Pune University has been named "Savitribai Phule Pune University" (SPPU) and therefore necessary refinements in the name were used for searching the Scopus database. It is also observed that the dataset includes the names of affiliated colleges as these colleges mentioned the University's name in their addresses. Moreover, four national institutes are located in the university campus and they also use the University's name in their addresses. The following search string was used to query the Scopus database.

AFFIL (University Pune) AND AFFIL (physics) AND NOT AFFIL (nccs) AND NOT AFFIL (iucaa) AND NOT AFFIL (ncra) AND NOT AFFIL (cdac) AND (LIMIT-TO (AF-ID , "Savitribai Phule Pune University" 60031475)) AND (LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-

TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2007) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2002) OR LIMIT-TO (PUBYEAR , 2001) OR LIMIT-TO (PUBYEAR , 2000) OR LIMIT-TO (PUBYEAR , 1999) OR LIMIT-TO (PUBYEAR , 1998) OR LIMIT-TO (PUBYEAR , 1997) OR LIMIT-TO (PUBYEAR , 1996) OR LIMIT-TO (PUBYEAR , 1995) OR LIMIT-TO (PUBYEAR , 1994) OR LIMIT-TO (PUBYEAR , 1993) OR LIMIT-TO (PUBYEAR , 1992) OR LIMIT-TO (PUBYEAR , 1991) OR LIMIT-TO (PUBYEAR , 1990) OR LIMIT-TO (PUBYEAR , 1989))

The dataset obtained was checked and curated manually. The final dataset consisted of 1629 publications with 22618 citations.

Analysis

Figure 1 shows that there is a steady growth in publications. Out of the 1629 publications, 1405 publications are articles followed by 191 conference proceedings. There are just 12 review papers, 3 editorials, 2 letters, 2 notes and 14 other types of publications.

International collaborations

Faculty members have published papers with scientists from the USA, UK, Germany, Japan, Canada, Singapore, South Korea, etc. Figure 2 shows the collaborations with different countries. Circles indicate the country and lines indicate the collaborations. The size of the circles indicates the number of collaborations and USA with the largest circle has the highest collaborations followed by Germany and South Korea.

National collaborations

Figure 3 shows collaborations within India. SPPU has the highest number of collaborations with Bhabha Atomic Research Center (BARC), Mumbai; Indian Institute of Science Education and Research (IISER), Pune; Indian Institute of Technology (IITs); as well as with other universities including Shivaji, Mumbai, Mangalore and Manipal universities, etc.

Preferred journals

Table 1 shows the top 12 journals in which faculty members published more than 25 papers. The table also lists Impact Factor (IF) and Quartile Score as per Journal Citation Report (JCR) and Scimago Journal

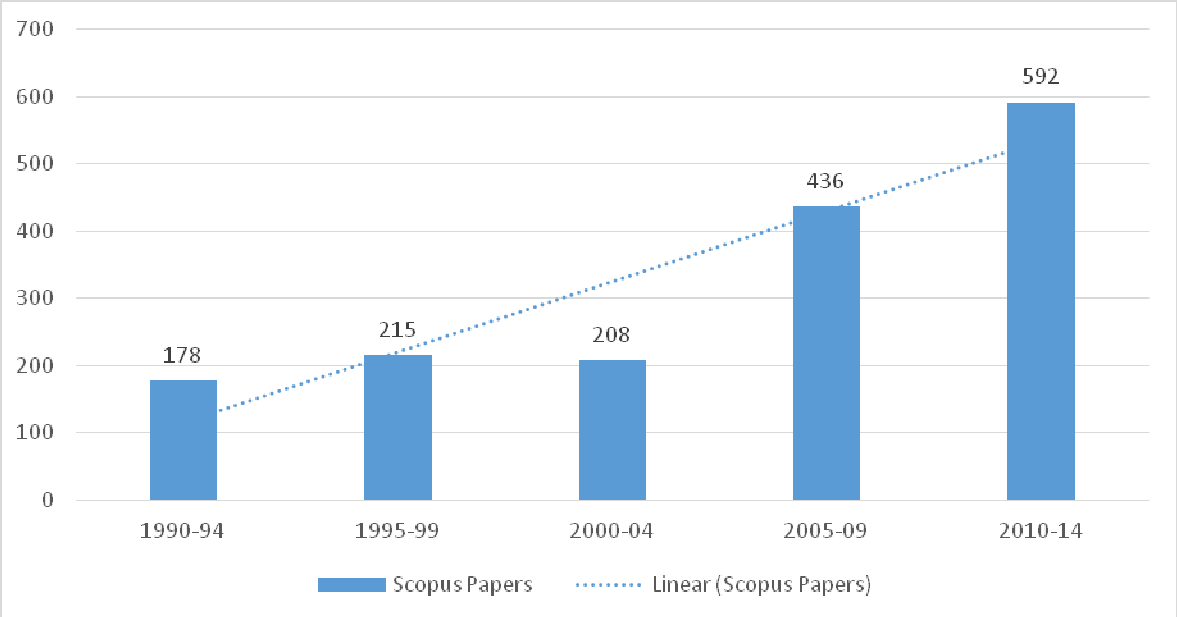

Fig. 1—No. of publications and citations

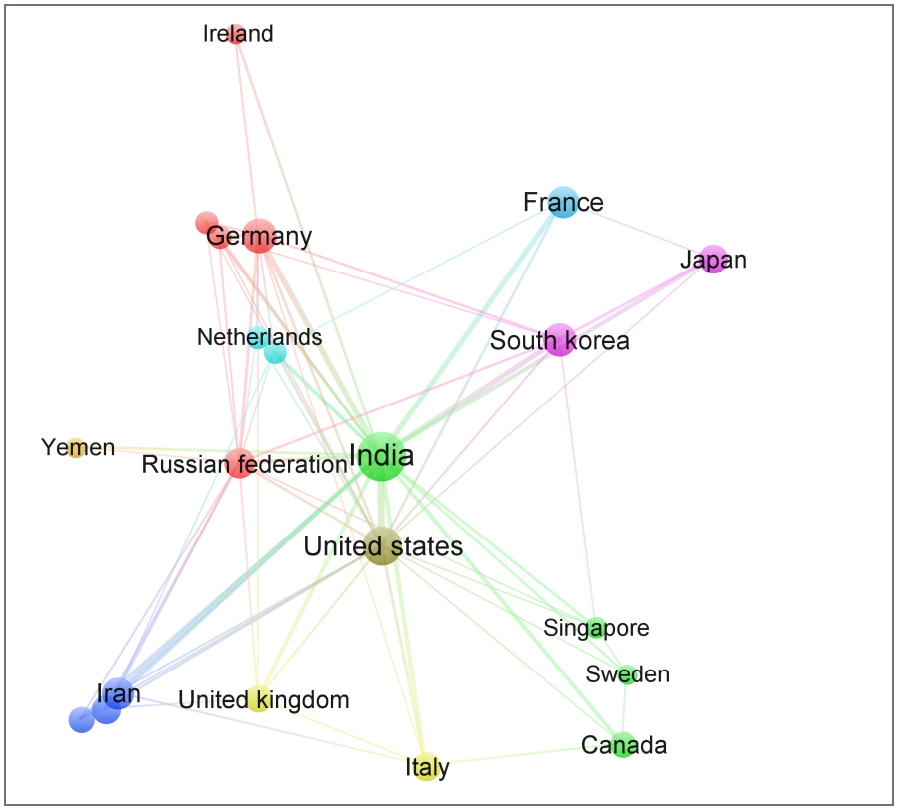

Fig. 2—International collaborations

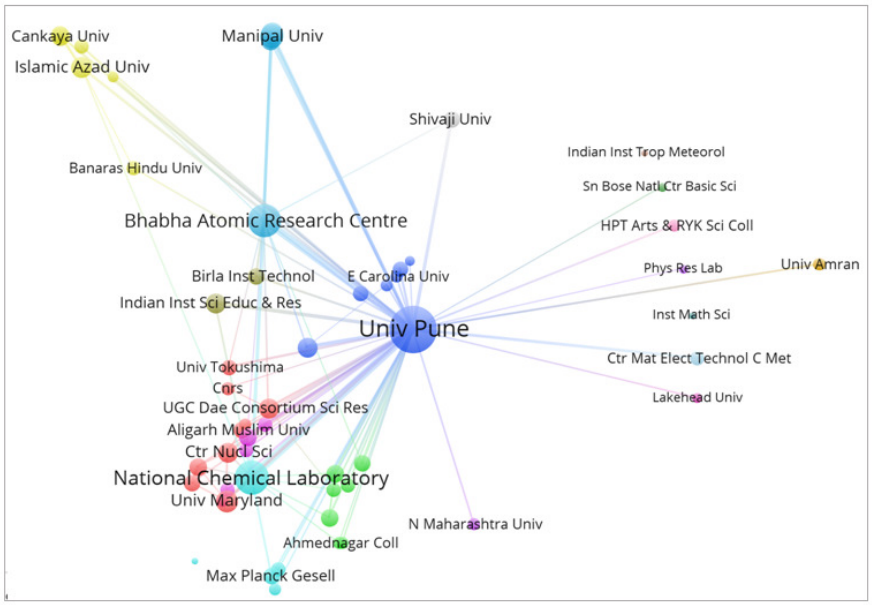

Fig. 3—National collaboration

Rank (SJR) and quartile from Scopus database. The overall observations are as follows:

- The highest number of citations are received for papers published in core physics journals viz. *Journal of Applied Physics* (1842), *Applied Physics Letters* (1705), *Physical Review B* (1462).
- Among 12 journals the quartile of journals differs as per JCR and SJR. As per JCR Q1 status is for

Table 1—Top 25 preferred journals

Sl no.	Journal	Place of publication	Scopus		JCR & Quartile		SJR & Quartile	
			Papers	Citations	IF	Quartile	SJR	Quartile
1.	*Journal of Applied Physics*	USA	72	1842	2.183	Q2	0.912	Q1
2.	*Applied Physics Letters*	USA	57	1705	3.302	Q1	1.62	Q1
3.	*Physical Review B*	USA	56	1462	3.736	Q1	2.33	Q1
4.	*AIP Conference Proceedings*	USA	52	13			0.15	-
5.	*Thin Solid Films*	Netherland	44	937	1.759	Q2	0.69	Q2
6.	*Nuclear Instruments & Methods In Physics Research Section B-Beam Interactions With Materials And Atoms*	Netherland	38	290	1.124	Q3	0.6	Q2
7.	*Materials Letters*	Netherland	35	642	2.489	Q1	0.85	Q1
8.	*Applied Surface Science*	Netherland	31	362	2.711	Q2	0.91	Q1
9.	*Solid State Communications*	Netherland	28	202	1.897	Q2	0.82	Q1
10.	*Journal of Physics D-Applied Physics*	UK	26	324	2.712	Q1	-	-
11.	*Journal of Chemical Physics*	USA	25	468	2.952	Q1	1.21	Q1
12.	*Physical Review A*	USA	25	268	2.808	Q1	1.83	Q1

Table 2—Authorship pattern as per Scopus

Authors	1990-1994		1995-1999		2000-2004		2005-2009		2010-2014		Total	
	Paper	Citations	Papers	Citations	Papers	Citations	Papers	Citations	Papers	Citations	Papers	Citations
1	7	53	9	161	6	12	10	18	6	2	38	246
2	34	445	45	738	29	330	54	577	61	141	223	2231
3	26	177	44	501	44	814	81	1284	93	513	288	3289
4	44	336	41	935	33	1129	86	1165	92	580	296	4145
5	37	392	25	670	38	912	65	1052	105	824	270	3850
6	16	177	20	640	23	572	52	948	78	452	189	2789
7	8	38	12	372	19	997	40	947	57	391	136	2745
8	3	63	8	560	4	188	29	457	37	279	81	1547
9	3	54	2	23	5	84	7	152	33	236	50	549

six journals whereas as per SJR, Q1 status is for eight journals. In JCR there are 4 Q2 status journals whereas in SJR there are only two journals that have Q2 status. Q3 status is only for one journal in JCR.

- API conference proceedings show 52 papers but there is no quartile mentioned in Scimago and also in JCR databases.
- Journal Impact factor of JCR ranges from 1.124 to 3.736 whereas SJR ranges from 0.15 to 2.33.

Authorship pattern

Table 2 shows the authorship pattern as per Scopus database grouped in five-year periods. Only papers with up to 9 authors have been considered here. There is one paper that has 72 authors and there are 57 papers that have 10 to 18 authors. It is seen that collaborative papers increased during 2010-2014 and single authored papers decreased during the same period. Earlier studies have mentioned that single-authored publications have declined over the years especially in the field of science and technology[19-20].

Keywords and research areas

Author keywords (Table 3) given in Scopus database were checked. It is noticed that faculty members are working in core subjects like physics and interdisciplinary subjects like chemistry, material sciences, engineering, instrumentation and nuclear science technology, etc. N-Gram tool of KWIC software was used to check the word sequences that

Table 3—Author keywords as per Scopus database

Sl. no.	Keywords	Nos.
1.	X-Ray	539
2.	Electron Microscopy	356
3.	Ray Diffraction	349
4.	Field Emission	262
5.	Scanning Electron	252
6.	Thin Films	140
7.	Synthesis Chemical	140
8.	Transmission Electron	134
9.	Zinc Oxide	120
10.	Photoelectron Spectroscopy	116
11.	Diffraction Analysis	104
12.	Infrared Spectroscopy	96
13.	Vapor Deposition	95
14.	Ray Photoelectron	95
15.	Fourier Transform	93
16.	Nanostructured Materials	89
17.	Transform Infrared	87
18.	Particle Size	85
19.	Chemical Vapor	75
20.	Microscopy X	73
21.	Emission Current	69
22.	Atomic Force	66
23.	Room Temperature	64
24.	Force Microscopy	64
25.	Doping Additives	58
26.	Diffraction X	57
27.	Current Density	56
28.	Optical Properties	55
29.	Raman Spectroscopy	53
30.	Electric Properties	52
31.	Pulsed Laser	50

appeared in author keyword fields. It is seen that that 31 keywords were used more than 50 times viz. x-ray diffractions, electron microscopy, thin films, scanning electron etc. This indicates that faculty members are active in these research areas. Keywords that appeared once or twice include crystallization fusarium, ablation, absorption, keying molecular, etc.

Conclusion

The quantitative analysis of papers published by the faculty members of the Department of Physics of SP Pune University during the 25 years (1990-2014) shows that the faculty members are very active in research areas like applied physics, chemical physics, material sciences, microwave and optical technology, nuclear physics, solid state, thin solid films, etc. There is also a steady growth in research output and as has been reported in earlier studies, single authorship is found to be declining.

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