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# Research Productivity of Saha Institute of Nuclear physics (SINP), India with special reference to International Collaborative Experimental Consortia

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## Research Productivity of Saha Institute of Nuclear physics (SINP), India with special reference to International Collaborative Experimental Consortia

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**Abstract:** The Saha Institute of Nuclear Physics (SINP) is one of the prestigious autonomous research institutes under the *Department of Atomic Energy, Govt. of India*. The present study is carried out to identify the research performance of the scientists of SINP during 2005-2016. For this purpose, a total number of 3694 articles as reflected in *Web of Science* (WoS) database have been retrieved and evaluated on the basis of year, authorship, publication pattern, source journal, impact factor, collaborating institution, country, research area and citation. Out of total publications, the international collaborative research output constitute 41.20% share and western developed nations i.e. *USA, Germany, Italy* have been found as the most favoured countries for collaborations. The institute has produced significant number of research articles participating with international collaboration experimental groups or consortia like *ALISC, CMS, MAGIC* and *PICASSO*. The scientists of SINP also select some foreign reputed journals to publish their maximum research findings and of these, *Physics Letters B* journal has been found as the most preferred source journal.

**Keywords:** Scientometric study, Publications output, Saha Institute of Nuclear Physics, DAE.

### 1. Introduction

The Saha Institute of Nuclear Physics (SINP), Kolkata, a premier autonomous research institute under the *Department of Atomic Energy (DAE), Govt. of India* is famous for its outstanding contribution in the field of nuclear science and allied disciplines. As a part of the *University of Calcutta*, the building of the *Institute of Nuclear Physics* was inaugurated on 11 January 1950 by Madame Irene Joliot-Curie. On 16th February 1956, when the founder director, Professor Meghnad Saha passed away, the Institute was renamed as Saha Institute of Nuclear Physics. Later, since 1992, the Institute became autonomy research institute under the administrative control of the *Dept. of Atomic Energy (DAE), Govt. of India*<sup>1</sup>. SINP is now engaged in basic scientific research on four broad subject areas, namely, (a) Astroparticle physics and Cosmology, (b) Experimental Nuclear, Particle & Plasma Physics, (c) Condensed Matter Physics, Surface

Physics and Material Science (d) Biophysics and structural Genomics, Crystallography & Molecular Biology, Computational sciences and Chemical sciences<sup>2</sup>. The present research team of the institute comprises of 89 faculty members, 137 research fellows and 34 post-doctoral fellows<sup>2</sup>. The Nature Index highlighted<sup>3</sup> SINP as one of the top-ten Indian institutions in the context of recognized global institutions and also reported<sup>4</sup> that the institute is amongst the top ten Indian institutions which have maximum collaborations with the international institutions.

The performance and scientific contribution of a research institute can be ascertained by analyzing the research outcome in the form of published journals literature. Thus, the present scientometric study is an attempt to assess the publication pattern of the SINP scientists and its impact by evaluating the primary journal articles.

## 2. Review of the related literature

The review of literature summarizes and highlights the previous scientometric literature on Nuclear Science and Technology research in India, contribution of the DAE institutes and allied areas. For instance, Kademani et al.<sup>5</sup> highlighted the growth and development of Nuclear Science and Technology research in India during 1970-2002 and showed that a total of 55,313 papers were published by the Indian Nuclear scientists. The average Indian contribution to the world literature was 2.25% and the *Pramana- journal of physics* was found as the most favoured journals.

Surwase, Kademani and Kumar<sup>6</sup> assessed research publications on *Neutron Scattering* research during 1991-2006 as reflected in Scopus database and found that *USA* was the top producing country while *India* placed the 12<sup>th</sup> position. From Indian institutions, the *Bhabha Atomic Research Centre (BARC), Mumbai* produced maximum publications whereas the *Saha Institute of Nuclear Physics (SINP), Kolkata* placed 3<sup>rd</sup> position in terms of research publication productivity.

Kumar<sup>7</sup> analysed the publication productivity of the *Department of Atomic Energy (India)* Institutions during 2008-12 and showed that the *Bhabha Atomic Research Centre (BARC)* produced highest number of publications while the *Saha Institute of Nuclear Physics* positioned the 4<sup>th</sup> place. *Physics and astronomy* subject occupy maximum number of publications and *AIP Conference Proceedings* has been found as the most preferred source title.

Jeevan & Sen<sup>8</sup> examined the journal publications of two accelerator-based research facilities in India, the *Nuclear Science Centre (NSC)* and *Tata Institute of Fundamental Research (TIFR)* during 1997-1999. The study revealed that the contribution of *NSC* in this field is double compared to the Accelerator Group of *TIFR*. But, *TIFR* placed their paper in higher impact journals compared to *NSC*.

In his study, Jeyshankar<sup>9</sup> evaluated the 5171 research publications of scientists of the *Indira Gandhi Centre for Atomic Research (IGCAR)* during the period 1989-2013 and stated that majority (23.38%) of the publications are four authored. The IGCAR scientists preferred to publish their work in the *Journal of Nuclear Materials* and the *Indian Institute of Technology, Chennai* was found as the leading collaborating institution.

In another two papers, Kademani et al.<sup>10</sup> and Upadhye<sup>11</sup> et al. analysed the publications of the *Bio-organic division* and *Nuclear Physics Division* at *Bhabha Atomic Research Centre* (BARC), *India* respectively. The average numbers of publication per year in both the divisions were 15.3 and 42.83 respectively and multi-authored collaboration trend has also seen in the publication pattern. The publication behavior of BARC scientists indicates that they were highly selective in dissemination of their research results in highly specialized journals.

### 3. Objectives of the study

The present study is an effort to bring in to light the research productivity of SINP in the form of published journals literature and their impact in attaining the higher position of the institute both at national and global level. The major objectives are to:

- i. identify the publications growth and year wise research output,
- ii. sketch the authorship pattern and international research collaboration,
- iii. illustrate the publications trend and the preferred source journals,
- iv. examine the impact factor wise distribution of journals and articles,
- v. depict the leading collaborating institutions and countries,
- vi. map out the most productive research areas,
- vii. reveal the highly cited articles, citation pattern and citation statistics.

### 4. Data source, limitations and methodology

The Web of Science (WoS) core collection database<sup>12</sup> of Clarivate Analytics has been consulted during the 2<sup>nd</sup> and 3<sup>rd</sup> week of April, 2018 to identify the quantum of research publications in the form of scholarly articles. The annual report<sup>13, 14</sup> of the institute is also intensely studied. Further, full text of some of the articles has also been verified to get more accurate data. The study is restricted to research ‘article’ publications of the scientists of Saha Institute of Nuclear Physics (SINP), Kolkata, India for the period of 12 years ranging from 2005 to 2016. The following search strategies are applied to retrieve the required data.

- a) Organization-enhanced: ‘Saha Institute of Nuclear Physics’ (selected from index)
- b) Document type : ‘article’
- c) Time span : ‘2005-2016’

The query results a sum total of 3,694 articles with their bibliographical details. The raw data, thus retrieved, is organized, scrutinized and exported to spreadsheet for further analysis. The resultant data in the form of tables and charts are examined and figured out to interpret judiciously and effectively the impact of research output of SINP. The Thomson Reuters ‘Journal Citation Report-2017’ has also been consulted to find out the impact factor (IF) of source journals.

### 5. Results and discussion

The following sections presented and interpreted the bibliographical details of 3694 scholarly articles in the form of tables, charts, figures on various parameters like year wise publication, authorship pattern, collaborative trend, corporate authors’ collaboration, preferred journal, impact factor, research area and citation.

#### 5.1 Year wise publication and international collaboration

The article publications output and international collaboration trend by years has been depicted in Table 1 and Figure 1. The scientists of SINP contribute a total number of 3694 research articles comprising of 1522 Internationally Collaborated Articles (ICA) which share 41.20% of total publications. There has been a steady growth in publications output from 177 articles in 2005 to 460 articles in 2016 and 49 articles in 2005 to 241 articles in 2012 for total article publications and internationally collaborated articles respectively. Table 1 transpires that during last five years from 2012 to 2016, the research article publications and international collaboration trend have been reached in a momentum. The Compound Annual Growth (CAG) rate shows an overall increasing trend of 9.07% for total article publications and 36.66% for internationally collaborative publications. Further, the 3694 research articles receive 17.23 average citations per paper having h-index of 92 while the internationally collaborated articles (ICA) receive 27.13 average citations per paper having h-index of 86. Hence, international collaborated articles (ICA) attract greater citations impact compared to article publications.

The mathematical formula for calculation of Compound Annual Growth Rate<sup>15</sup> is mentioned below:

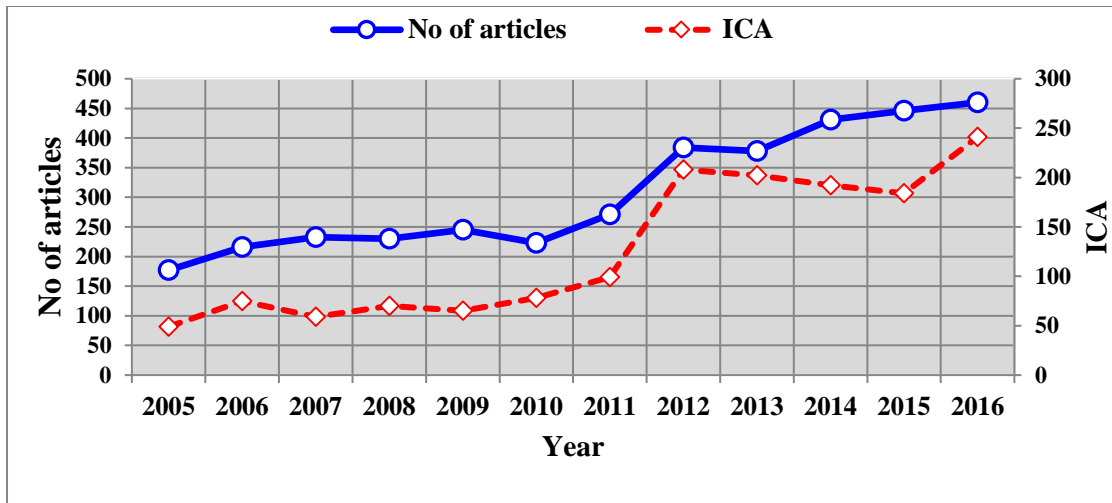
$$\text{Compound Annual Growth Rate (CAGR)} = \left( \frac{\text{Ending Value}}{\text{Beginning Value}} \right)^{\left( \frac{1}{\# \text{ of years}} \right)} - 1$$

$$\text{Compound Annual Growth Rate \%} = \text{CAGR} \times 100$$

**Table 1: Publications output and international collaboration output by years**

Sl. No.	Year	No. of articles	%	Compound Annual Growth Rate %	ICA	%ICA	Compound Annual Growth Rate %
1.	2005	177	4.8	-	49	3.20	-
2.	2006	216	5.85	22.03	75	4.92	53.06
3.	2007	233	6.31	7.87	59	3.87	-21.33
4.	2008	230	6.22	-1.28	70	4.6	18.64
5.	2009	245	6.63	6.52	65	4.27	-7.14
6.	2010	223	6.04	-8.98	78	5.12	20
7.	2011	271	7.33	21.52	99	6.50	26.92
8.	2012	384	10.4	41.7	208	13.66	110.10
9.	2013	378	10.23	-1.56	202	13.27	-2.88
10.	2014	431	11.67	14.02	192	12.61	-4.95
11.	2015	446	12.07	3.48	184	12.1	-4.16
12.	2016	460	12.45	3.14	241	15.83	30.97
Total =		3694	100	9.07	1522	100	36.66
Avg. citations per paper =		17.23	-	-	27.13	-	-
h-index		92	-	-	86	-	-

*ICA= Internationally collaborated articles*



**Figure 1: Trend of publication output and international collaboration.**

## 5.2 Authorship pattern and their citations

Authorship trend among the SINP scientists is illustrated in table 2. It is seen from the table that more than ten authored (>>10) have shared the highest number of articles of 852 (23.06%) articles followed by three authored with 708 articles (19.16%), two authored with 673 articles (18.22%) and four authored with 446 articles (12.07%). The citation count further shows that more than ten authored articles have attracted maximum of 32,730 citations with an average 38.415 citations per paper followed by eight authored articles with an average of 16.93 citations per paper. More than ten authored articles have the highest h-index of 82.

**Table 2: Authorship pattern and citation impact**

Authorship	No. of articles	%	Sum of times cited	Avg. citations per paper	h-index
1	243	6.58	1880	7.736	22
2	673	18.22	6262	9.30	22
3	708	19.16	8268	11.678	25
4	446	12.07	5207	11.675	22
5	319	8.63	4011	12.57	20
6	178	4.82	1900	10.674	17
7	128	3.46	1295	10.117	17
8	63	1.70	1067	16.93	16
9	51	1.38	560	10.98	12
10	33	0.9	483	14.63	13
>>10	852	23.06	32730	38.415	82
Total =	3694	100	63,663	17.23	92

## 5.3 Corporate authors' collaboration trend

Corporate author means group authors experimenting under international scientific collaborating consortia. Table 3 highlights the distribution of articles by corporate authors. Out of total 628 corporate articles, the scientists of SINP produce maximum number of 449 articles (71.5%) as a participating partner institution with CMS collaboration experimental group followed by ALICE collaboration with 150 articles (23.9%). The ALICE collaborated papers receive maximum of 58.326 average citations per paper followed by PICASSO Collaborated papers with 58.25 average citations per paper. Further, the SINP articles collaborating with CMS and ALICE experimental groups also receive maximum h-index of 62 and 52 respectively.

**Table 3: Distribution of articles by corporate authors**

<b>International collaboration experimental groups</b>	<b>No of articles</b>	<b>%</b>	<b>Sum of times cited</b>	<b>Avg. citations per paper</b>	<b>h-index</b>
CMS Collaboration, Switzerland	449	71.5	14158	31.532	62
ALICE Collaboration, Switzerland	150	23.9	8749	58.326	52
MAGIC Collaboration, Spain	9	1.43	161	17.888	6
VERITAS Collaboration, USA	7	1.11	97	13.857	6
PICASSO Collaboration, Canada	4	0.63	233	58.25	4
Others	9	1.43	367	40.777	4
Total =	628	100	23765	37.84	77

#### 5.4 Publications trend

Table 4 demonstrates the scattering of journals and their share of the total number of articles. Maximum number of 234 journals (49%) contribute only 6.33% i.e. 234 articles while major portion of 1287 articles which constitute 34.84% share publish in 7 journals (1.46%) only. It is also found from the table that nearly half of the total articles i.e. 1801 (48.75%) publish in only 15 journal titles (3.13%). The shape of the figure 2 highlights that the scientists of SINP have preferred some selective core journals to publish their research findings.

**Table 4: Publication pattern by journals and articles**

<b>Publication Pattern</b>	<b>Articles</b>	<b>%Articles</b>	<b>Journals</b>	<b>%Journals</b>
One time	234	6.33	234	49
Two times	124	3.35	62	13
Three times	126	3.41	42	8.8
Four times	92	2.5	23	4.81
Five times	115	3.11	23	4.81
6-10 times	227	6.14	31	6.5
11-20 times	428	11.6	30	6.27

21-30 times	303	8.20	12	2.51
31-50 times	244	6.60	7	1.46
51-100 times	514	13.91	8	1.67
More than 100 times	1287	34.84	7	1.46
Total =	3694	100	479	100

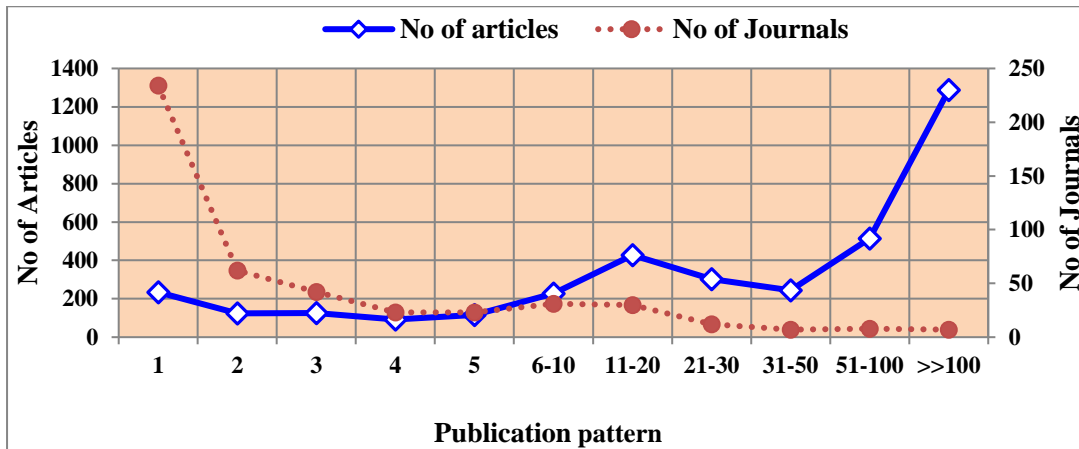


Figure 2: Publication trend of articles

### 5.5 Distribution of preferred source journals

Table 5 portrays the list of top 15 preferred source journals by the SINP scientists. A total 3694 articles publish in 479 journals of repute and the top 15 journals produce a cumulative number of 1801 articles which share 48.75% of total articles. Out of total journals, *Physics Letters B* journal having IF of 4.807 leads the table with 254 articles, followed by *Journal of High Energy Physics* having IF of 6.063 with 244 articles and *Physical Review D* having IF of 4.568 with 234 articles. The articles publish in *Physical Review Letters* having IF of 8.462 receive maximum of 68.25 average citations per paper. Besides, the articles published in *Physics Letters B* receive wider citations impact with h-index of 56 and also highest number of 26 articles cites at least 100 or more times.

Table 5: Preferred source journals

Sl. No.	Name of the Journal with IF, 2017	No. of articles	Sum of times cited	Avg. citations per paper	h-index	AC <sub>100</sub>
1.	Physics Letters B, 4.807	254	14,866	58.53	56	26
2.	Journal of High Energy Physics, 6.063	244	3,556	14.57	29	01
3.	Physical Review D, 4.568	234	3,622	15.48	31	02
4.	Physical Review C, 3.820	210	4,014	19.11	34	06
5.	European Physical Journal C, 5.331	120	3,440	28.66	31	09



6.	Physical Review B, 3.836	115	1,851	16.1	24	00
7.	Physical Review Letters, 8.462	110	7,508	68.25	48	24
8.	Journal of Applied Physics, 2.068	85	957	11.26	16	00
9.	Physics of Plasmas, 2.115	83	405	4.88	10	00
10.	Physical Review E, 2.366	80	732	9.15	15	00
11.	Journal of Radioanalytical and Nuclear Chemistry, 1.282	56	305	5.45	9	00
12.	Journal of Instrumentation, 1.220	54	677	12.54	11	01
13.	RSC Advances, 3.108	53	325	6.13	9	00
14.	Applied Physics Letters, 3.411	52	1076	20.7	18	02
15.	Pramana-Journal of Physics, 0.520	51	114	2.23	5	00
Others ( 464 Journals)=		1893	20,256	10.7	48	15

$AC_{100}$ = Number of articles with at least 100 or more citations

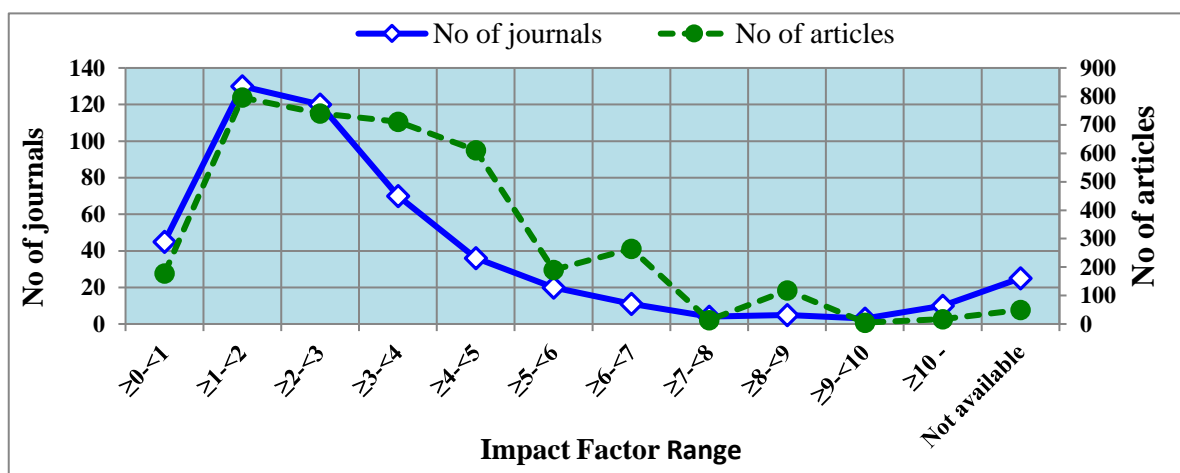
### 5.6 Impact Factor wise distribution of journals and articles

Table 6 portrays the distribution of journals and articles by impact factors (IF). Highest number of 796 articles (21.55%) publish in 130 journals (27.14%) having IF range of  $\geq 1 < 2$  followed by 740 articles (20.03%) in 120 journals (25%) having IF range of  $\geq 2 < 3$  and 711 (19.25%) articles in 70 journals (14.61%) with IF of  $\geq 3 < 4$ . Only 17 articles publish in 10 journals having IF range of  $\geq 10$ . The average IF per paper (i.e. available 3644 papers) is 3.478. The line diagram of figure 3 expresses that the scientists of SINP prefer to publish their papers in high impact factor journals.

**Table 6: Distribution of journals and articles by Impact Factors**

Sl. No.	IF Range (JCR, 2017)	Total Journals	%	Total Articles	%
1	$\geq 0 < 1$	45	9.4	178	4.82
2	$\geq 1 < 2$	130	27.14	796	21.55
3	$\geq 2 < 3$	120	25	740	20.03
4	$\geq 3 < 4$	70	14.61	711	19.25
5	$\geq 4 < 5$	36	7.51	611	16.54
6	$\geq 5 < 6$	20	4.17	190	5.14
7	$\geq 6 < 7$	11	2.3	264	7.14

<b>8</b>	$\geq 7 < 8$	04	0.83	14	0.38
<b>9</b>	$\geq 8 < 9$	05	1	118	3.2
<b>10</b>	$\geq 9 < 10$	03	0.62	05	0.13
<b>11</b>	$\geq 10 -$	10	2.1	17	0.46
<b>12</b>	Not available	25	5.22	50	1.35
Total =		479	100	3694	100
Average IF/ paper =				3.478	



**Figure 3: Distribution of Journals and articles by impact factors.**

### 5.7 Collaborating institutions

Table 7 reveals the leading collaborating institutions with the SINP. It is seen from the table that the *Istituto Nazionale Di Fisica Nucleare* of Italy collaborated maximum of 714 articles closely followed by the *Helmholtz Association* of Germany with 707 articles. Besides, the 640 collaborated articles with *European Organization for Nuclear Research CERN* of Switzerland receive maximum average citations of 44.97 per paper followed by the 646 articles of *University of California System* of USA with 44.93 average citations per paper. However the 687 collaborated articles with *United States Department of Energy DOE* receive maximum h-index of 82. Out of top 10 collaborating institutions, 9 are foreign institutions while only 1 from India.

**Table 7: Top 10 collaborating institutions**

Sl. No.	Name of the institution/ organization	Country	Number of Articles	Times Cited	Avg. Citations Per Item	h-index
1	Istituto Nazionale Di Fisica Nucleare	Italy	714	30,370	42.54	79
2	Helmholtz Association	Germany	707	30,458	43.08	80
3	Centre National De La Recherche Scientifique CNRS	France	695	30,162	43.4	79

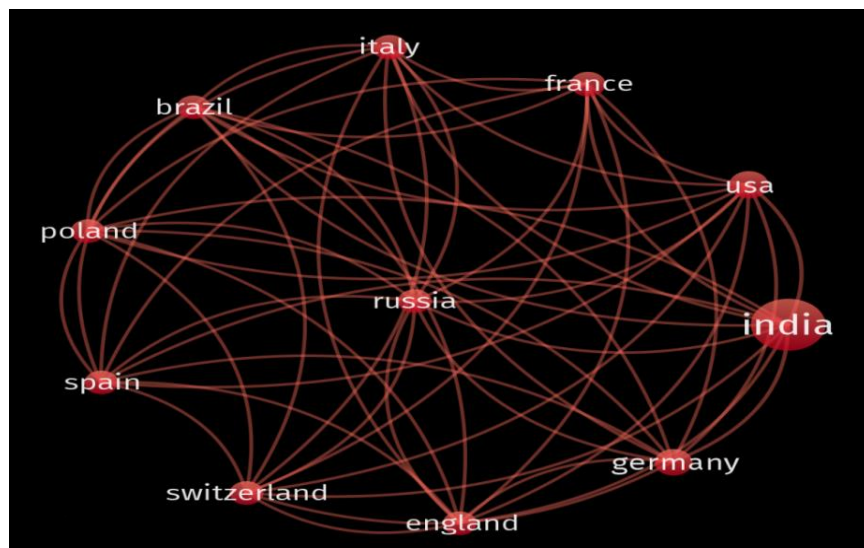
4	United States Department of Energy DOE	USA	687	30,576	44.51	82
5	Universite Paris Saclay Comue	France	673	29,727	44.17	79
6	The French Alternative Energies and Atomic Energy Commission or CEA	France	670	29,282	43.7	78
7	CNRS National Institute of Nuclear Particle Physics in2p3	France	661	29,631	44.83	79
8	University of California System	USA	646	29,026	44.93	79
9	European Organization for Nuclear Research CERN	Switzerland	640	28,783	44.97	79
10	Panjab University	India	640	28,708	44.86	79

### 5.8 Collaborating countries

Table 8 shows the leading collaborating countries with the scientists of SINP and their share of the total number of articles. The scientists of SINP collaborated and co-authored research articles with a total of 77 countries. Of these, the *USA* ranks the top position and share maximum number of 920 articles. This is followed by *Germany* with 878 articles and *Italy* with 752 articles. Besides, the 693 collaborated articles with *Poland* receive maximum average citations of 44.15 per paper followed by the 670 articles of *Switzerland* with average citations of 44.10 per paper. However, the collaboration articles of *USA* and *Germany* receive maximum h-index of 84 and 82 respectively. Using VosViewer software, figure 4 sketches the network visualization map of top ten collaborating countries.

**Table 8: Leading collaborating countries**

Country	No. of articles	Sum of times cited	Avg. citations per paper	h-index
USA	920	33,377	36.28	84
Germany	878	32,615	37.15	82
Italy	752	30,994	41.22	80
France	750	30,844	41.13	79
Poland	693	30,594	44.15	81
England	682	29,960	43.93	79
Spain	681	30,001	44.05	79
Brazil	672	29,145	43.37	79
Switzerland	670	29,549	44.10	79
Russia	664	29,159	43.91	79
Others (67) =	2397	25,591	10.68	54



**Figure 4: Network visualization map of top 10 collaborating countries with SINP (India)**

### 5.9 Productive research areas

Table 9 presents the most productive research area wise distribution of the articles. Out of top 10 most productive research areas, the highest number of 574 articles publishes in *Astronomy astrophysics* discipline which also gets greater citations impact in terms of average citations per paper and h-index. This is followed by *Materials Science* discipline with 317 articles and *Nuclear Science Technology* discipline with 193 articles.

**Table 9: Most productive research areas**

Rank	Research Areas	No of Articles	Sum of times cited	Avg. citations per paper	h-index
1.	Astronomy astrophysics	574	19594	34.13	62
2.	Materials Science	317	3729	11.76	32
3.	Nuclear Science Technology	193	1396	7.23	17
4.	Biochemistry Molecular Biology	191	2364	12.37	25
5.	Instruments instrumentation	137	1403	10.24	18
6.	Biophysics	113	1362	12.05	21
7.	Engineering	58	633	10.91	14
8.	Optics	51	516	10.11	13
9.	Polymer Science	47	546	11.61	13
10.	Radiology nuclear medicine & medical imaging	36	314	8.72	11

### 5.10 Most cited papers

Table 10 depicts the top five most cited articles. Of these, *Physics Letters B* journal publishes 3 articles and *Physical Review Letters* publish 2 articles. It is noteworthy to mention that all the

five research articles are written by SINP scientists collaborating with international institutions under experimental consortia like *ALICE*, *CMS*.

**Table 10: Top Five Highly Cited Articles**

Sl. No.	Title of the Article	Authors	Source Journal	Year	Times Cited
1.	Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC	Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M. et al. Group author(s): CMS Collaboration	Physics Letters B	2012	4537
2.	Combined results of searches for the standard model Higgs boson in pp collisions at root s=7 TeV	Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M. et al. Group author(s): CMS Collaboration	Physics Letters B	2012	442
3.	Higher Harmonic Anisotropic Flow Measurements of Charged Particles in Pb-Pb Collisions at root s(NN)=2.76 TeV	Aamodt, K.; Abelev, B.; Abrahantes Quintana, A. et al. Group author(s): ALICE Collaboration	Physical Review Letters	2011	430
4.	Elliptic Flow of Charged Particles in Pb-Pb Collisions at root s(NN)=2.76 TeV	Aamodt, K.; Abelev, B.; Abrahantes Quintana, A. et al. Group author(s): ALICE Collaboration	Physical Review Letters	2010	415
5.	Suppression of charged particle production at large transverse momentum in central Pb-Pb collisions at root s(NN)=2.76 TeV	Aamodt, K.; Abrahantes Quintana, A.; Adamova, D. et al. Group author(s): ALICE Collaboration	Physics Letters B	2011	377

### 5.11 Citation wise distribution of articles

Table 11 illustrates the data related to citation range and their share of the total number of articles. Out of total 3694 articles, highest number of 1880 articles (50.9%) has cited  $\geq 1$  -  $< 10$  times, followed by 720 articles (19.5%) with  $\geq 10$  -  $< 20$  citations and 548 articles (14.83%) with  $\geq 20$  -  $< 50$  citations. Only 18 articles (0.48%) receive minimum 200 or more citations and 300 articles (8.12%) remain uncited.

**Table 11: Citation pattern by articles**

Sl. No.	Citation Range	No of articles	%articles	Cumulative articles
1.	$\geq 1$ - $< 10$	1880	50.9	1880
2.	$\geq 10$ - $< 20$	720	19.5	2600
3.	$\geq 20$ - $< 50$	548	14.83	3148

4.	$\geq 50 - <100$	160	4.33	3308
5.	$\geq 100 - <200$	68	1.84	3376
6.	$\geq 200 -$	18	0.48	3394
7.	Uncited	300	8.12	3694
Total =		3694	100	--

### 5.12 Citations statistics

Table 12 reports the citation details of journal article publications. Total 3694 articles have cited 63,663 times and the citing articles are 36,678. The average citations per article are 17.23 and the h-index of SINP research articles is 92.

**Table 12: Citation report**

Citation details	Total
Total Articles	3,694
Sum of times cited	63,663
Sum of times cited without self-citations	56,302
Avg. Citations per article	17.23
Citing articles	36,678
Citing articles without self-citations	34,247
h-index	92

## 6. Conclusion

The study depicts that the scientists of SINP produce a large number quality publications during last 12 years and a steady growth has been seen in the research articles productivity as well as in the international collaborations. The international collaborative research output constitute 41.20% share of total publications. The scientists also publish research output at selective and specialized foreign journals of repute and also collaborate with good numbers of institutions originated from western developed nations, namely, USA, Germany, Italy, and France. Besides, the majority of the research output is in *Astronomy astrophysics* and *Materials Science* discipline.

The scientists of SINP have contributed significantly in Large Hadron Collider (LHC) research activities at CERN through CMS, ALICE and ISOLDE collaborations<sup>12</sup>, in dark matter search at SNOLab through PICASSO collaborations<sup>13</sup>, in functional beamline at Photon Factory (KEK), Japan<sup>14</sup>. The SINP has signed an agreement<sup>16</sup> with Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany that will allow researchers in India access to PETRA III, the world's best high energy synchrotron light source. The Institute has made a Memorandum of Understanding<sup>13</sup> (MoU) with Cavendish Laboratory, University of Cambridge to participate in a joint-PhD program through Saha-Cambridge Scholarship program towards building a new avenue of research collaboration between the institutes. Hope, despite many hurdles, the Institute will

continue and move forward the legacy of scientific research for the benefit of the society and mankind, as dreamt by Prof Meghnad Saha, the founder of the institute.

Now, the Institute and its library professionals should take initiative to design and implement online institutional repository system so that the scholarly content can be archived and disseminated publicly in the open access environment for wider distribution of research results.

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