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# Scientometric Analysis of the Research Output of Physics and Astronomy of Guru Nanak Dev University during 2006-15

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**ABSTRACT**

The study attempts to analyse research contributions of the Guru Nanak Dev University, Amritsar in physics and astronomy during the period 2006-15. The data for this study was extracted from Scopus. The study analyses the year-wise research productivity, national and international collaborations, top collaborating institutions, most prolific authors, journals used for communication, most preferred journals for publication, number of citations received by the University during the period under study. This paper analyses that the university has published 652 papers in physics and astronomy. The University had registered the average citation impact per paper of 7.01 per cent and 6 publications received 51 to 100 citations. Among the Indian universities, University stood at 23rd rank in term of publications output (652) and h-index (29), 16th rank in average citation per paper (7.01 per cent) and 18th rank in share of high cited papers (1 per cent) and 19th rank in terms of international collaborative papers (27.45 per cent) during 2006-15. Around 68.71 per cent publications of the University in physics and astronomy were in national collaboration between GNDU and several other Indian organisations. The study clearly indicates that journals are the most preferred form of publication to communicate research works by the researchers.

**Keywords:** Guru Nanak Dev University; Physics; Physics and Astronomy; Scopus; Bibliometrics; Scientometrics; Citation Analysis

## 1. INTRODUCTION

Reputation and prestige of any institution greatly depends upon its research productivity and its impact. Various rating organisations and funding agencies give weight to research publications of an institute. The present study examines research output of Guru Nanak Dev University in physics and astronomy by using scientometric techniques.

Scientometric analysis technique has emerged in the last few years and it fundamentally deals with the study of quantifying and analysing science and technology and overall research performance of an institution. It is a science of the application of mathematical and statistical methods which are often developed to measure and evaluate the scientific publications. Being a unique research area, scientometrics is utilised to quantify national and international systems of innovation which helps in developing policy in science and technology and derives long term economic and social benefits. It is utilised to identify the pattern of publication, authorship, productive author, author affiliation, year-wise growth, citations and behaviour of a subject over a period of time and thereby offering insight into the dynamics of the area under study which in turn may help to formulate science policy[1].

Guru Nanak Dev University was established at Amritsar on November 24, 1969 to mark the 500th birth anniversary of Sri Guru Nanak Dev Ji. It is both a residential and an affiliating university. According to the objectives in the Guru Nanak Dev University Act 1969, the University would make provision for imparting education and promoting research in the humanities, learned professions, sciences, especially of applied nature and technology. University has risen to 16th rank in the top 50 universities of the country, as per survey conducted by 'India Today'. University Grants Commission, New Delhi has declared University with potential for excellence. The National Assessment and Accreditation Council have accredited the university with a CGPA of 3.5 out of 4 with 'A' Grade. NAAC, Bengaluru has placed Academic Staff College of the University at 12th rank. In the field of science and technology, University is one of the prime institutions in north India. The apex bodies like the Department of Telecommunications, Council of Scientific & Industrial Research, Bhabha Atomic Research Centre (BARC) and other organisations have awarded prestigious projects to faculty members worth millions of rupees. BARC has established Nodal Calibration Centre at the campus[2].

The Department of Physics, Guru Nanak Dev University was established in 1972 and offers courses leading to the degrees of B.Sc. (Honours), M.Sc. (Honours), MPhil and PhD programmes. Various funding agencies like Board of Research in Nuclear Sciences (BRNS), Council of Scientific & Industrial Research (CSIR), Department of Science and Technology (DST), Defence Research and Development Organisation (DRDO), Department of Atomic Energy (DAE), University Grants Commission (UGC), etc., have sanctioned several

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projects to the faculty of the department. The department has been adopted by the UGC under Special Assistance Programme (SAP) and Department of Science and Technology (DST) under fund for improvement of science and technology infrastructure in universities and higher educational institutions (FIST) programme. During the last five years, the department has received more than Rs. 28 millions of research grant in around 19 research projects from various scientific national originations[3].

## 2. REVIEW OF LITERATURE

Singh[4], *et al.* analysed contributions and Citation impact of Panjab University in Chemistry research during 2008-15. The study quantified 833 publication data extracted from the Scopus citation database in various aspects of performance. The study found that the Panjab University total publications in chemistry has increased at an annual average growth rate of 17.04 % and registered an average citation impact per paper of 6.38 during 2008-15. The study reveals that the 28.69 % and 25.81 % of the Panjab University publications in chemistry were involved in national and international collaboration and among its performance in top 20 most productive Indian universities, Panjab University stood at 16th rank in terms of publications output (833) and h-index (27), 13th rank in average citation per paper (6.38 %) and share of high cited papers (0.12 %) and 8th rank in terms of international collaborative papers (25.81 %) during 2008-15.

Trapp[5], did a bibliometric study of papers published in the field of medical physics and biomedical engineering. The study analysed differences in a publication's citation count of papers published in the journal Australasian Physical for medical physics and biomedical engineering papers and Comparison was made between the Web of Science, Scopus, and Google Scholar. Papers are categorised into subject matter, and citation trends are examined. The study shown that the review papers as a group tend to receive more citations on average; however the highest cited individual papers are more likely to be research papers.

Abdullah[6], *et al.* investigated the performance of electromagnetic fields (EMF) research work using bibliometric analysis covering the period 2003–2013. They extracted a total number of 1737 articles from the IEEE ICES EMF database and did the study which focused on the distribution and growth of publications across journals, titles, and fields over the period, and collaboration network patterns among scholars and scientists. They found that fields of Engineering &Physics produced the highest number of articles while Epidemiology journals showed the most outstanding performance across all fields. 1651 (95 per cent) of the articles were identified as co-authored publications, indicating involvement in a collaborative network.

Bansal[7], *et al.* in their study analysed the contribution and citation impact of Panjab University in Mathematics research during 2005-14 from the Scopus database. 230 research papers in the field of mathematics were analysed.

Nagarkar[8], *et al.* analysed the research productivity of life sciences of the Savitribai Phule Pune University (SPPU), Maharashtra, India during 1999-2013 using Web of Science (WoS) database. Data were analysed by using bibliometric techniques and software such as HistCite, Intcoll, and Pajek. The study analysed year wise research productivity, its citation impact, collaborations, and authorship patterns, etc. The study reveals that the research productivity is increasing, their publications are getting good citations and thereby their journals have better Impact Factor. The faculty members of SPPU have collaborated with prominent international researchers and have extended interdisciplinary research.

Siwach[9], *et al.* investigated the research contributions of Maharshi Dayanand University, Rohtak in terms of its publication output during 2000-2013. They examined a total number of 1247 papers in the manifestation of journal articles and reviews along with articles in press as available in Scopus database. The study found that the Chemistry has been the front runner as research subject of which the largest numbers of articles were published in Indian Journal of Heterocyclic Chemistry. The study reveals that the amongst the productive authors, C.S. Pundir of the Department of Biochemistry is having highest number of publications and P.K. Jaiwal of Department of Biotechnology was having largest citations per paper in terms of its average number.

Hanumappa[10], *et al.* in their study undertook bibliometric analysis of the research publications of Gujarat University during 2004–2013. The study found that the collaboration was highest in the year 2012 at 0.70 based on the modified collaboration coefficient. The most preferred journal for publication by Gujarat University faculty was Acta Poloniae Pharmaceutica-Drug Research and the most cited author of Gujarat University was P.S. Srivastav, while V.K. Jain had the best average citations per paper.

Vasishta[11] investigated the contribution and impact of research output of PEC University of Technology during 1996-2009. The study compared publications output and citation impact of PEC with select similar neighboring engineering institutions. The study found that the growth in the academic research output is seen after the PEC has acquired the deemed university status. It suggested that the there is intense requirement to develop suitable research environment and upgrading infrastructural facilities.

Kaur[12] did bibliometric study on research publications of Department of Chemistry, Guru Nanak University, Amritsar for the period 2002-2006 in her study analysed all the 269 articles of Guru Nanak Dev University published in the field of Chemistry from 84 journals. The findings showed the number of publications has increased consistently from the years 2002 to 2006. The majority of the publication is made with 3 authors. The department has published 45 % of the papers at their own and 55 % are published in collaboration with other department /institution. Amongst these, collaboration with other departments and foreign institution was observed. The department has a large number of the publications from journal.

Flores[13], *et. al* in their bibliometric study focused on the application of metric indicators for the study of physics research at the National Autonomous University of Mexico (UNAM) and its characteristic specialists groups in the decade of the 90s. They explored the characteristics of the highly productive research groups (GIMP) and their evolution. They

suggested that the results and the methodology applied can be extrapolated to other knowledge areas and can be used as a point of comparison and evaluation for other disciplines at the UNAM and like universities.

Kumbar[14], *et al.* described the growth, contribution and impact of research carried out by the scientists of University of Mysore in science and technology during 1996-2006. The study found that University of Mysore is on growing path with annual 23 % average rate of publication in Science and Technology. The study found that the Chemistry, Physics, Astronomy, Biochemistry are its dominating research areas.

Garg[15], *et al.* analysed 3174 papers published in journals in the field of Laser Science and Technology. It indicated that only 401 papers were single authored and the rest 2773 were co-authored papers. Of the 2773 collaborated papers, only 687 were collaborated at domestic and national levels, and the rest was at international level.

Dhawan[16] examined physics research in India and China using Physics Abstracts for the years 1990 and 1995. He found that China was ahead of India in terms of publication output, however average impact per paper for India was higher than China.

Raina[17] done the bibliometric analysis of physics research in India between 1900 and 1950. They found that in the newer areas of physics a greater percentage of physicists contributed to the discipline. While the older disciplines were dependent on the researches undertaken by a few individuals and their teams of researchers. They observed that about 32 physicists constituted the core community of physicists during this half century, and all published in more than one sub-discipline of physics. Study highlighted the appearance of Indian journals and the practice initiated by Indian physicist to publish in Indian journals and promoted physics research in India.

As it has been found that no such study has been done on Guru Nanak Dev University in the physics and astronomy, hence this study is unique and will highlight the research publication of Guru Nanak Dev University in the physics and astronomy.

## 3. OBJECTIVES

The main objectives are to study the research output of Guru Nanak Dev University (GNDU) in Physics and Astronomy Research during 2006-15, based on publications output, as indexed in Scopus database. In particular, the study focuses on:

(i) Growth of research output of GNDU and its distribution by type of type of documents and sources.
(ii) Impact of GNDU research publications in Physics and astronomy during 2006-15 using citations per paper
(iii) To compare GNDU research performance in Physics and Astronomy with other leading universities of India during 2006-15
(iv) Contribution and citation impact of top 20 most productive authors of GNDU in Physics and astronomy
(v) To examine the national and international collaborations of GNDU with other universities in Physics and astronomy.
(vi) Leading medium of communication and characteristics of high cited papers

## 4. METHODOLOGY

The publication data of GNDU in physics and astronomy was retrieved and downloaded from the Scopus database. To assess the research output the publications of GNDU in physics and astronomy over a ten-year period of (2006-2015) were considered. 'Affiliation search' with first keyword 'Guru Nanak Dev University' was started and then limited this search to years 2006 to 2015. When all the publication of Guru Nanak Dev University was found, it has been further restricted to 'Physics and Astronomy' in 'Subject Area' tag. Hence a total number of 652 publications were retrieved. The final search strategy string used is given below.

( AFFILCITY ( amritsar ) AND AFFILORG ( guru nanak dev ) AND PUBYEAR > 2005 AND PUBYEAR < 2016 AND LIMIT-TO ( SUBJAREA , "PHYS" )

When the main search string is further restricted to 'author name tag' (complete count),' source title tag', 'keyword tag' 'Affiliation tag' and 'Country/Territory tag', information on distribution of publications by author, source, significant keywords, collaborating organisations and countries, etc was found. To assess the research output of top 25 Indian universities in physics and astronomy during the period of (2006-2015) 'Affiliation Country Search' was done with keyword 'India' and then limited this search to 2006 to 2015. This search was further restricted to 'Physics and Astronomy' in 'Subject Area' tag. Further the obtained data was restricted to only universities by selecting individual university in Affiliation Tag to compare GNDU with other Indian universities. The study has used both quantitative and qualitative indicators to study the performance of GNDU in physics and astronomy research.

## 5. DATA ANALYSIS

### 5.1 Comparison with other Indian Universities

The top 25 most prolific Indian universities in physics and astronomy during 2006-15, individually contributed from 576 to 2859 publications and mutually contributed 29243 publications, which account for only 24.73 % share of India's publication output (118273) in physics and astronomy during this period. Amongst these 25 Indian Universities during 2006-15, GNDU ranked 23$^{rd}$ in terms of the publications output (652) and ranked 7$^{th}$ in terms of h-index (29), 16$^{th}$ in average citation per paper (7.01 %) and 18$^{th}$ in high cited papers (1 %). Of the 25 universities, 3 universities have published papers in the publication range 2001 to 2859, 8 universities in the publication range of 1001-2000 and the remaining 14 in publication range of 575 to 1000. The combined publication output of these 25 universities as reflected in Table 1 is 29243 papers. The average output of these 25 universities is 1170 papers. Of the total universities, 9 universities have published above the average output of these universities during 2006-2015. Among these universities, the largest number of papers (2859) is published by University of Delhi, followed by Panjab University (2411), Jadavpur University (2271), Banaras Hindu University (1693), Anna University (1583), University of Hyderabad (1546), Mangalore University (1517), University of Calcutta (1391), and University of Madras (1162).

### 5.2 Publication Output and Citation Impact

In Guru Nanak Dev University, number of overall publications and those in the field of physics and astronomy consisted of 2936 and 652 publications, respectively during 2006-15, increased from 220 and 38 to 378 and 73, respectively witnessing an average growth rate of 6.7 % and 9.6 % during 2006-15. In GNDU the cumulative publications output and those in the area of physics and astronomy increased from 1184 and 277 publications during respectively 2006-10 to 1752 and 375 publications respectively during 2011-15, witnessing growth rate of 47.97 % and 35.38 %. The share of physics and astronomy output in the overall of GNDU was 22.21 % during 2006-15, which decreased from 23.39 % to 21.40 % from 2006-10 to 2011-15. The share of physics and astronomy citations in the overall citations of GNDU was 16.00 % during 2006-15 which increased from 15.82 % to 16.29 % from 2006-10 to 2011-15. The average citation per paper registered by physics and astronomy publications of GNDU was 7.01 % during 2006-15, which scaled down from 10.22 % to 4.63 % from 2006-10 to 2011-15. The average Publication share per paper registered by physics and astronomy publications of GNDU was 22.21 % during 2006-15, which scaled down from 23.39 % to 21.40 % from 2006-10 to 2011-15. The average citation share per paper registered by physics and astronomy publications of GNDU was 16 % during 2006-15, which scaled up from 15.82 % to 16.29 % from 2006-10 to 2011-15 as shown in Table 2.

### 5.3 Distribution of Publications in terms of Collaboration

Collaboration in the scientific research is necessary and useful for universalisation and validation of the research. In collaborative research a numbers of experts contribute to the given research. Multiplicity of contributing brains helps increase quality of research. The increasing trend of collaboration indicates that there are collaboration between the academics and scientists. The authors affiliated to GNDU have collaborated with authors of other institutes of India as well as other countries.

Among collaborating organisations of GNDU in physics and astronomy, the largest number of collaborative papers (30) was with Bhabha Atomic Research Centre followed by Inter

**Table 1. Scientometric profile of top 25 Indian Universities in physics and astronomy**

| Name of the University | TP | TC | ACPP | HI | HCP (above 50) | %HCP |
|---|---|---|---|---|---|---|
| University of Delhi | 2859 | 40015 | 13.99 | 72 | 131 | 4.58 |
| Panjab University, Chandigarh | 2411 | 50479 | 20.93 | 92 | 222 | 9.21 |
| Jadavpur University, Kolkata | 2271 | 17136 | 7.54 | 46 | 29 | 1.28 |
| Banaras Hindu University, Varanasi | 1693 | 18150 | 10.72 | 53 | 57 | 3.37 |
| Anna University, Chennai | 1583 | 9939 | 6.28 | 38 | 18 | 1.14 |
| University of Hyderabad | 1546 | 11971 | 7.74 | 42 | 30 | 1.944 |
| Mangalore University | 1517 | 5786 | 3.81 | 28 | 5 | 0.33 |
| University of Calcutta | 1391 | 8787 | 6.32 | 33 | 13 | 0.934 |
| University of Madras | 1162 | 5014 | 4.31 | 29 | 13 | 1.12 |
| University of Mysore | 1051 | 3857 | 3.67 | 19 | 5 | 0.474 |
| Aligarh Muslim University | 1049 | 11530 | 10.99 | 46 | 37 | 3.53 |
| Savitribai Phulle Pune University | 992 | 8364 | 8.43 | 39 | 19 | 1.91 |
| University of Rajasthan | 968 | 15013 | 15.50 | 59 | 71 | 7.33 |
| Annamalai University | 963 | 8511 | 8.84 | 39 | 27 | 2.80 |
| Sri Venkateshwara University, Tirupati | 872 | 8110 | 9.30 | 38 | 20 | 2.29 |
| Cochin University of Science and Technology | 825 | 5969 | 7.23 | 34 | 14 | 1.70 |
| Thapar University | 826 | 4074 | 4.93 | 25 | 6 | 0.73 |
| University of Allahabad | 722 | 5386 | 7.46 | 34 | 14 | 1.94 |
| Madurai Kamraj University | 701 | 3414 | 4.87 | 25 | 6 | 0.85 |
| Bharathidasan University | 688 | 5705 | 8.29 | 32 | 12 | 1.74 |
| Bharathiar University, Coimbatore | 660 | 4210 | 6.38 | 26 | 9 | 1.36 |
| Shivaji University | 658 | 8429 | 12.81 | 41 | 24 | 3.65 |
| **Guru Nanak Dev University, Amritsar** | **652** | **4568** | **7.01** | **29** | **7** | **1.00** |
| Bengal Eng. & Sci University | 607 | 4377 | 7.21 | 28 | 4 | 0.66 |
| Maharaja Siyaji Rao University of Baroda | 576 | 3400 | 5.90 | 28 | 3 | 0.52 |
| Total | 29243 | 272194 | 9.30 | 975 | 796 | 2.72 |

**Table 2. Publication output and citation impact of GNDU in physics and astronomy**

| Publication year | Guru Nanak Dev University | | Guru Nanak Dev University physics and astronomy output | | | | |
|---|---|---|---|---|---|---|---|
| | TP | TC | TP | TC | ACPP | PS | CS |
| 2006 | 220 | 3892 | 38 | 543 | 14.29 | 17.27 | 13.95 |
| 2007 | 196 | 3390 | 35 | 336 | 9.60 | 17.86 | 9.91 |
| 2008 | 244 | 3798 | 60 | 804 | 13.40 | 24.59 | 21.17 |
| 2009 | 260 | 3432 | 71 | 590 | 8.31 | 27.31 | 17.19 |
| 2010 | 264 | 3381 | 73 | 558 | 7.64 | 27.65 | 16.50 |
| 2011 | 302 | 2915 | 77 | 498 | 6.47 | 25.50 | 17.08 |
| 2012 | 312 | 2835 | 70 | 445 | 6.36 | 22.43 | 15.70 |
| 2013 | 370 | 2536 | 80 | 363 | 4.54 | 21.62 | 14.31 |
| 2014 | 390 | 1747 | 75 | 318 | 4.24 | 19.23 | 18.20 |
| 2015 | 378 | 628 | 73 | 113 | 1.55 | 19.31 | 17.99 |
| 2006-2010 | 1184 | 17893 | 277 | 2831 | 10.22 | 23.39 | 15.82 |
| 2011-2015 | 1752 | 10661 | 375 | 1737 | 4.63 | 21.40 | 16.29 |
| 2006-2015 | 2936 | 28554 | 652 | 4568 | 7.01 | 22.21 | 16.00 |

TP= Total papers; TC= Total citations; ACPP= Average citations per paper; PS= Publication share; CS=Citation share

University Accelerator Centre India (27), Punjabi University Patiala (18), Thapar University (16), Panjab University (16), Tata Institute of Fundamental Research (15), Indian Institute of Technology Roorkee (12) and so on.

Of the 652 publications by Guru Nanak Dev University in physics and astronomy, 108 (16.56 %) involved international collaboration during 2006-15. The international collaboration decreased from 19.13 % during 2006-10 to 14.67 % during 2011-15 (Table 3). These 108 international collaborative papers have received 1028 citations, leading to the average citation impact per paper of 9.52 %, more than the citation impact of overall publications of GNDU in physics and astronomy (7.01 %). A large number of organisations and scholars from 30 foreign countries collaborated in research with GNDU, of which the largest number of papers came from USA, Canada, South Korea and United Kingdom.

**Table 3. Distribution of publications of Guru Nanak Dev University in physics and astronomy by national and international collaboration**

| Publication year | TP | NCP | % NCP | ICP | % ICP |
|---|---|---|---|---|---|
| 2006 | 38 | 24 | 63.16 | 11 | 28.95 |
| 2007 | 35 | 16 | 45.71 | 10 | 28.57 |
| 2008 | 60 | 25 | 41.67 | 12 | 20 |
| 2009 | 71 | 30 | 42.25 | 8 | 11.27 |
| 2010 | 73 | 26 | 35.62 | 12 | 16.44 |
| 2006-10 | 277 | 121 | 43.68 | 53 | 19.13 |
| 2011 | 77 | 30 | 38.96 | 17 | 22.08 |
| 2012 | 70 | 31 | 44.28 | 5 | 7.14 |
| 2013 | 80 | 32 | 40 | 6 | 7.5 |
| 2014 | 75 | 48 | 64 | 14 | 18.67 |
| 2015 | 73 | 41 | 56.16 | 13 | 17.81 |
| 2011-2015 | 375 | 182 | 48.53 | 55 | 14.67 |

TP= Total papers; NCP= National collaborative publications; ICP= International collaborative publications

### 5.4 Top Collaborating Countries

A large number of organisations and scholars from 30 foreign countries collaborated in research with GNDU.

Of which the largest number of papers (19) came from USA, followed by Canada (15) South Korea (14) United Kingdom (13) Spain (10) Botswana (8) Denmark (7) Italy (6) Trinidad and Tobago (6) and Australia (5) respectively during 2006-15. Collaboration contribution per country varied from 1 to 19 papers in 10 years. In all 9 countries contributed 1 paper each, 4 countries 2 papers each, 1 country 3 paper, 4 countries 4 papers each, 2 countries 5 papers each, 3 countries 6 papers each, 1 country each 7, 8, 10, 13, 14, 15 and 19 papers during 2006-2015.

### 5.5 Medium of Communication

Out of total 652 papers published by GNDU during 2006-15, 593 papers appeared in 157 journals, 58 in conference proceedings and 1 in book series. Of these 55 journals published 1 paper each; 34 journals 2 papers each; 16 journals 3 papers each; 16 and 15 journals 4 and 5 papers each; 6,5,3,2 and 2 journals 6,7,8,9,10 papers each; 10 journals each 11 to 20 papers, 3 journal each 21 to 55 papers during 2006-15. 15 most productive journals that published 10 and more papers is given in Table 4. The top 15 journals, in which 267 papers were contributed, account for 40.95 % share of journals during 2006-15. The largest number of papers (55) was published in AIP conference proceedings, followed by Sensors and Actuators B Chemical (24), Physics of plasmas (22), Nuclear instruments and methods in physics research (21), and so on.

### 5.6 Highest Impact Factor Journals

It is clear from the Table 5, GNDU faculty members published their research in the journal Advanced Functional Material which has highest impact factor (11.38) followed by Advances in Colloid and Interface Science (7.813), Monthly Notices of the Royal Astronomical Society (4.9), Nuclear Sensors And Actuators B Chemical (4.758) Physical Chemistry Chemical Physics (4.449), and so on.

### 5.7 Distribution of Publications by Impact Factor

Of the 652 publications by Guru Nanak Dev University in Physics and astronomy, 593 publications appeared in 157 journals. Of these 157 journal publications, only 578 publications appearing in 148 journals had impact factor information. The largest number of publications (227) appeared in 52 journals with impact factor range 1.01 to 2.00, 152 publications in 43 journals with impact factor range from 0.01 to 1.00, 129 publications in 39 journals with impact factor range 2.01 to 3.0, 64 publications in 12 journals with impact factor range 3.01 to 5.0, 2 publications in 2 journals with impact factor range 5.01 and above. The average impact factor per publication was 0.46 for these 578 publications as shown in Table 6.

**Table 4. Top 15 most productive journals**

| Journal | TP | IF 2015 | Publisher |
|---|---|---|---|
| *AIP conference proceedings* | 55 | ---- | American Institute of Physics (United States) |
| *Sensors and Actuators B Chemical* | 24 | 4.758 | Elsevier Science ( Suisse) |
| *Physics of plasmas* | 22 | 2.207 | American Institute of Physics (AIP) NY |
| *Nuclear Instruments and Methods in Physics Research* | 21 | 1.200 | Elsevier |
| *Optik* | 18 | 0.742 | Urban und Fischer Verlag Jena (Elsevier) (Netherlands) |
| *Physics B Condensed Matter* | 17 | 1.352 | Elsevier |
| *Indian Journal of Physics* | 16 | 1.166 | Springer Science+Business Media on behalf of the Indian Association for the Cultivation of Science |
| *Radiation measurements* | 14 | 1.071 | Elsevier |
| *Radiation physics and Chemistry* | 13 | 1.207 | Elsevier Science ( Royaume-Uni) |
| *EPJ Applied Physics* | 12 | 0.667 | EDP Sciences, Springer Science+Business Media,Società Italiana di Fisica |
| *Langmuir* | 12 | 3.993 | American Chemical Society (United States) |
| *Journal of Non Crystalline Solids* | 11 | 1.825 | Elsevier |
| *Journal of Optoelectronics and Advanced Materials* | 11 | 0.383 | National Institute of Research and Development for Optoelectronics Romania |
| *Structural Chemistry* | 11 | 1.854 | Springer New York |
| *Computational and Theoretical Chemistry (Formerly known as Journal of Molecular Structure THEOCHEM)* | 10 | 1.403 | Elsevier |

### 5.8 Contribution and Citation Impact of Top 20 Authors

Total 160 authors contributed to physics and astronomy research in Guru Nanak Dev University during 2006-15, of which 51 authors published 1 to 5 papers; 24 authors 6 to 10 papers; 32 authors 11 to 20; 7authors 21 to 30 papers; 3 authors 41 to 50 papers and 2 authors published above 51 papers. Of the 160 authors, the top 20 most productive authors individually published 16 to 54 publications and together contributed total of 606 publications and 4368 citations, accounting for 92.94 % share of total publications and 91.82 % share of total citations of GNDU in physics and astronomy during the period. The scientometric profile of top 20 most productive authors is given in Table 7. The average productivity per author was 30.3 % and 7 authors have published more than the average productivity per author.

### 5.9 Distribution of Publications by Citations

Of the total 652 publications by Guru Nanak Dev University in physics and astronomy 2006-15, 23.16 % (151 publications) did not get any citation (zero citation) since their publication till July 25, 2016. The remaining 76.84 % publications received 1 or more citations 55.52 % i.e. 362 publications received 1 to 10 citations that registered 33.89 % of total citations, 17.63 % i.e. 115 publications received 11 to 30 citations that registered 43.68 % citation share, 2.76 % i.e. 18 publications received 31 to 50 citations that registered 15.12 % citation share, and 0.92 % i.e. 6 publications received 51 to 100 citations that registered 7.31 % citation share during 2006-15 as shown in Table 8.

### 5.10 Highly Cited Papers

The top 15 highly cited papers (8 papers in 40 to 50 citations range; 6 papers in 51-70 citation range; 1 paper in 75-80 citation range) together account for 757citations, leading to the average citation per paper of 50.47. K.S. Thind (79 citations);

**Table 5. Top 15 highest impact factor journals**

| Name of the journal | TP | Name of Publisher | IF |
|---|---|---|---|
| *Advanced Functional Materials* | 1 | Wiley | 11.38 |
| *Advances in Colloid and Interface Science* | 1 | Elsevier | 7.813 |
| *Monthly Notices of The Royal Astronomical Society* | 1 | Wiley | 4.9 |
| *Sensors and Actuators B Chemical* | 24 | Elsevier Science(Suisse) | 4.758 |
| *Physical Chemistry Chemical Physics* | 6 | Royal Society of Chemistry | 4.449 |
| *Crystal Growth and Design* | 8 | American Chemical Society | 4.425 |
| *Langmuir* | 12 | American Chemical Society | 3.993 |
| *CrystEngComm* | 2 | Royal Society of Chemistry | 3.849 |
| *Journal of Colloid and Interface Science* | 4 | Elsevier | 3.782 |
| *Physical Review B Condensed Matter and Materials Physics* | 2 | American Physical Society | 3.718 |
| *Materials Science and Engineering C* | 1 | Elsevier | 3.420 |
| *International Journal of Hydrogen Energy* | 2 | Elsevier | 3.205 |
| *ChemPhysChem* | 1 | Wiley | 3.138 |
| *Applied Physics Letters* | 1 | AIP Publishing | 2.99 |
| *Acta Crystallographica Section B Structural Science Crystal Engineering and Materials* | 3 | Wiley | 2.892 |

**Table 6. Distribution of publications in physics and astronomy by impact factor**

| Range of impact factor | No of papers | No. of journals |
|---|---|---|
| 0.01-1.00 | 156 | 43 |
| 1.01-2.0 | 227 | 52 |
| 2.01-3.0 | 129 | 39 |
| 3.01-4.0 | 25 | 8 |
| 4.01-5.0 | 39 | 4 |
| 5.01 and above | 2 | 2 |
| Total | 578 | 148 |

**Table 7. Top 20 most productive authors of Guru Nanak Dev University in physics and astronomy**

| Author | TP | TC | ACPP | HI |
|---|---|---|---|---|
| R. Thangaraj | 54 | 179 | 3.31 | 7 |
| S. Singh | 53 | 348 | 6.57 | 11 |
| R.K. Bedi | 50 | 291 | 5.82 | 10 |
| L. Singh | 48 | 256 | 5.33 | 8 |
| T.S. Gill | 44 | 387 | 8.79 | 13 |
| D. Singh | 41 | 198 | 4.83 | 9 |
| N.S. Saini | 32 | 280 | 8.75 | 10 |
| A. Mahajan | 29 | 172 | 5.93 | 9 |
| S. Kumar | 27 | 55 | 2.04 | 4 |
| D. Kaur | 25 | 158 | 6.32 | 7 |
| A. Khanna | 25 | 167 | 6.68 | 7 |
| S.B. Narang | 25 | 121 | 4.84 | 5 |
| T.S. Banipal | 24 | 321 | 13.37 | 10 |
| R.C. Singh | 21 | 206 | 9.81 | 8 |
| M. Singh | 20 | 100 | 5.00 | 7 |
| K.S. Thind | 20 | 335 | 16.75 | 11 |
| P.K. Banipal | 19 | 195 | 10.26 | 8 |
| S.S. Sekhon | 17 | 168 | 9.88 | 6 |
| A.S. Bains | 16 | 160 | 10.00 | 6 |
| G. Sharma | 16 | 271 | 16.94 | 11 |
| Total of 20 authors | 606 | 4368 | 7.21 | 8.35 |
| Total papers | 652 | 4757 | | |
| Share of 20 authors | 92.94 | 91.82 | | |

**Table 8. Distribution of publications in physics and astronomy by citations**

| Range of citations | TP | Citations | TP (%) | Citations (%) |
|---|---|---|---|---|
| 0-0 | 151 | 0 | 23.16 | 0 |
| 1-10 | 362 | 1612 | 55.52 | 33.89 |
| 11-20 | 81 | 1207 | 12.42 | 25.37 |
| 21-30 | 34 | 871 | 5.21 | 18.31 |
| 31-40 | 10 | 350 | 1.53 | 7.36 |
| 41-50 | 8 | 369 | 1.23 | 7.76 |
| 51-100 | 6 | 348 | 0.92 | 7.31 |
| Total | 652 | 4757 | 100 | 100 |

TP= Total Publications

S.S. Sekhon (57 citations); R.C. Singh (54 citations); S. Singh, D. Singh (51 citations each); A.S. Bains ,T.S. Gill (48 citations each); T.S. Benipal (50citations); S.B. Narang (49 citations); N.S. Saini (45 citations) are from the list of most productive 20 authors whose papers has received high citations.

Among 15 higher cited papers, 8 were single institution (zero collaboration), 2 involved national collaboration (participation of 2 or more Indian organisations) and 5 involved international collaboration (participation of 2 or more Indian and foreign organisation). These 15 higher cited papers involved 52 authors (including 32 from GNDU) and 13 organisations and were published in 9 journals. The largest number of papers (3 each) were published in Nuclear instruments and Methods in Physics Research, (Section B: Beam Interactions with Materials and Atoms) and Langmuir; 2 papers published in Physics Letters (Section A: General, Atomic and Solid State Physics) and Sensor and Actuators, B: Chemical and 5 other journals published 1 paper each: Journal of the Electrochemical Society, Radiation Measurements, Radiation Physics and Chemistry, Solid State Ionics, Crystal Growth and Design.

## 6. CONCLUSIONS

The Guru Nanak Dev University during 2006-15 published total 652 publications in physics and astronomy, with an annual average growth rate of 9.6 % and overall research productivity increased from 277 during 2006-10 to 375 in 2011-15, witnessing a growth rate of 35.38 %. Amongst the 25 most productive Indian Universities in physics and astronomy, GNDU stood at 23rd rank in term of publications output (652) and 7th rank in h-index (29), 16th rank in average citation per paper (7.01 %) and 18th rank in share of high cited papers (1 %) Among 652 papers in physics and astronomy by GNDU 160 authors participated, of which the top 20 most productive authors contributed 92.94 % and 91.82 % share to its total publications and citations during 2006-15. The top 15 comparatively higher cited papers appearing in citation range from 40-80 together account for 775 citations, leading to average citation per paper of 50.47 %. The study clearly indicates that journals are the most preferred form of publication to communicate their research works by the researchers of GNDU.

From analysis it is clear that Guru Nanak Dev University's contribution in physics and astronomy lags far behind other leading Indian universities, in terms of both publications output and citation impact. It is suggested that the university must give a genuine thought to expand its research output and raise its quality and impact. The university could increase through international collaboration not only the exploration efficiency of its researchers, but also may encourage change in citations of its publications**.** The university should create research promoting environment by building infrastructure facilities and conducting workshops to upgrade research and publishing efforts of its researchers. This will also enhance the reputation of the university and have a positive influence on university ranking. Extraordinary honors and incentives should be given to the faculty members for publishing in high impact journal. Proper strategies should be adopted to remove imbalances in

research output and to promote participatory research projects with other universities.

Although, GNDU library has subscription of many e-resources, there is further need to strengthen and enhance access to e-resources especially in the field of physics and astronomy and its allied subject areas. The findings of the research will be helpful for various strategy-making bodies and funding organisations to provide enhanced financial support to GNDU. It is also observed from this study that physics and astronomy contribution is at 3rd position among all the departments of GNDU. Therefore, it is suggested that if funding agencies provide more funds in term of research grant to this department, more research publications will be produced in future.

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