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SCIENTOMETRIC ANALYSIS OF LITERATURE ON GRAVITY

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ABSTRACT

The present study explores the quantitative analysis of literature on gravity from 2015 to 2019 based on INSPEC database. Scientometric is the study of quantitative analysis of scientific documents. For the present study data was collected from the INSPEC database published by Elsevier during the period from 2015 to 2019. The study evaluated the different dimensions of the scientometric analysis like, growth of literature, institution wise distribution, most prolific author, relative growth rate and doubling time etc. Highest number (7562) of articles published in the year 2018. The relating growth rate is decreasing and doubling time is increasing over the period. Majority of the articles are in the form of journals, China is the most productive country in global level, Sharif, M is the most prolific author in the field of gravity for the period of 2015 to 2019.

Keywords: *Gravity, Scientometric, INSPEC, Relative growth rate, Doubling Time*

1. Introduction

In all research and development subjects various statistical tools and techniques are used. Statistics has been used in all research areas over the past years. Statistics is to observe or discipline of gathering and evaluating statistical data in huge quantities, particularly for the idea of ascertaining dimensions in an entire from those in a representative sample (Manjula, 2017). The computer permitted to helpful analysis of data because of industrial development of science increase the quality of research publications (Selvavinayagam, 2018). The word metric was most used as part of measurement in different subject areas and library and information science also. A variety of metrics has been introduced by the different professionals like; librarmetry by Ranganathan, bibliometrics by Pritchard, scientometrics by Nalimov and Mulchenko for quantitative analysis of documents. Scientometric is the study of quantitative analysis and characteristics of science, technology and modernization using scientific techniques (Khan, 2016). Macias Chapula argues that "scientometric indicators have become essential to the scientific community to estimate the state-of-the-art of a given topic" (quoted in Lolis et. al. 2009). In other words scientometrics is the study of measuring and analyzing science, technology and innovation.

2. Concept of Gravity

According to Encyclopaedia of Britannica "gravity is also called gravitation in mechanics, the universal force of attraction acting between all matters. It is by far the weakest known force in

nature and thus plays no role in determining the internal properties of everyday matter" (Encycloaedia Britannica, 2019).

3. Review of Literature

Kumar et al (2011) analyzed the global level research trend in nuclear waste management during the period of 1970 to 2009 the data indexed in INIS database. The study revealed that The average number of papers published per year was 1113.23, the country United States of America ranked first by producing 6672 publications, in case of most productive institutions Japan Atomic Energy Agency placed the first position by contributing 677 papers and it was also evident from their study that majority of the papers are published in English language. Jancy et al (2013) conducted a scientometric study on Indian Journal of Pure and Applied Physics during 2008 to 2012. For the study the researcher covered a total of 690 articles in five volumes from 46 to 50 for analysis. The authorship pattern of contribution showed that highest number of papers was written by two authors and the degree of collaboration is 0.92. Santhakumar and Kaliyaperumal (2014) carried out a global mobile technology research publications covered in Engineering Index during the period of 2003 to 2012. Their study found an increasing trend of publications from 5789 publications in 2003 to 17515 publications in 2008, the highest numbers of publications was published in the year 2011, witnessing relative growth rate has decreased from 2003 to 2012 that is from 0.98 to 0.13 and the doubling time has increased from 071 to 5.15 from 2003 to 2012 respectively. Surwase et al (2014) study intended to analyze the world research publication on food preservation using Scopus database for the period 1998-2012. The study showed that 130countries were involved in international collaboration by producing 16.56%, England has the highest activity index 1.76 in 2002, Spanish National Research Council has ranked first by producing more number of research articles and majority of the researchers preferred Journal of Food Protection to publish their research articles.

A study done by Fay and Gautrias (2015) analyzed the 38291 papers available on the electronic archives arXiv.org on general relativity and quantum cosmology from 2000 to 2012 by using scientometric indicators. They found that majority of the articles contributed by multi-authors with international collaborations. The country Canada was one of the most contributed countries with highest collaboration and more number of research papers written by single author in Russia. Khanna et al (2017) had used an application of scientometric method to analyze the research productivity in Physics and Astronomy of Guru Nanak Dev University during 2006-15. They analyzed the research growth, citations per paper, compare with other leading universities of India, most prolific authors and analyzed the international collaboration. Among the Indian Universities, Guru Nanak Dev University stood at 23rd place in term of publications output and h-index (29), 16th rank in average citation per paper. Chandra (2018) has carried out a scientometric analysis of entrepreneurship as a field of research data retrieved by Web of Science database. The study aimed to study the growth of the area of entrepreneurship during 1990 to 2013. The study analyzed the significant contribution to the entrepreneurship research by determining 46 topics in the 24 year history of entrepreneurship research and indicates how they appear, disappear, reappear and stabilize over time. Shilpa et al. (2019) in their paper mapping the research publications on Leukemia indexed in Web of Science database. The result of this study showed that in global level highest number 16794 articles were published in 2016 and majority of the articles were authored by four, All India Institute of Medical Sciences was the most contributed institution in India.

4. Objectives

The objectives formulated for the study are;

- To know the research output in the field of gravity
- To find the distribution of literature based on journals
- To identify the relative growth rate and doubling time
- To illustrate the geographical distribution of publications
- To know the prolific authors in the field of gravity

5. Methodology

For the present study the publication data of gravity was retrieved and downloaded from the INSPEC database which is published by Elsevier. This database has covers the high quality, relevant and cross disciplinary content, enabling engineers and researchers to perform through and effective literature reviews, analyze the research landscape and solve problems. This is one of the most comprehensive engineering platform, contains journals, conference proceedings, dissertations, technical standards, trade magazines, technical reports and engineering information. The advanced search option was used to retrieve the necessary data. A total of 30,485 publications spanning over the years 2015 to 2019 were downloaded in 19th August 2019. The data was downloaded in csv file format and Microsoft excel spreadsheet was used to analyze the data.

6. Data Analysis and Interpretations

6.1 Growth of publications

Table 1 indicates the growth of publications on gravity output during the year 2015 to 2019 (5years). A total 30485 records were published during the period of study. The high number of publications 7562 (24.81%) were published in the year 2018 followed by 2017 i.e. 7294 (23.93%). In the year 2016 were 7016 (23.01%) publications followed by 2015 i.e. 6601 (21.65%) and 2012 (6.60%) articles are published in the year 2019.

6.2 Table-1: Growth of publications

Sl. No.	Years	Records	Percentage	Cumulative Records	Cum. Percentage
1	2015	6601	21.65	6601	21.65
2	2016	7016	23.01	13617	44.67
3	2017	7294	23.93	20911	68.59
4	2018	7562	24.81	28473	93.40
5	2019	2012	6.60	30485	100
	Total	**30485**	**100**		

6.2 Publication output and Types

The main source of publications covered by the INSPEC database on gravity is journal articles with 26236 (86.062%) followed by conference articles with 4104 (13.462%) publications. Dissertations conference ranks the 3rd position with 80 (0.262) records followed by proceeding with 31 records, book chapters with 29 records respectively. Books, report chapter and report review has least records on gravity (Table 2).

Table-2: Form-wise distribution of records

Sl. No	Forms of publications	No. of Records	Percentage
1	Journal articles	26236	86.062
2	Conference articles	4104	13.462
3	Dissertations	80	0.262
4	Conference proceedings	31	0.102
5	Book Chapters	29	0.095
6	Books	3	0.010
7	Report chapter	1	0.003
8	Report review	1	0.003
	Total	**30485**	**100**

6.3 Growth rate and doubling time

The relative growth rate is defined as the increase in number of articles or pages per unit of time (Mahapatra, 1994). The formula which is used to calculate the Relative growth rate as follows;

$$\overline{\boldsymbol{R}}\,(\boldsymbol{P}) = \frac{\mathbf{Loge^{2^P} - Loge^{1^P}}}{\mathbf{2^P - 1^P}}$$

Here $\overline{\boldsymbol{R}}\,(\boldsymbol{P})$ = relative growth rate of articles over the specific period of time

$Loge^{1^P}$ = Log of initial number of articles

$Loge^{2^P}$ = Log of final number of articles

The doubling time (Dt) was calculated as follows;

$$\boldsymbol{Dt(P)} = \frac{\mathbf{Loge^2}}{\overline{\mathbf{R}}\,\mathbf{(P)}} = \frac{\mathbf{0.693}}{\overline{\mathbf{R}}\,\mathbf{(P)}}$$

Here Dt(P) is average doubling time of articles

It has been found from the table 3 and figure 1 that the relative growth rate has decreased from 1.50 to 0.08 during the period. The doubling time has increases from 0.46 in 2016 to 8.57 in 2019.

Table-3: Relative growth rate (RGR) and Doubling time (DT) of records

Sl. No.	Year	No. of Records	Cumulative Records	Log_e W1	Log_e W2	RGR	DT
1	2015	6601	2012		7.61		
2	2016	7016	9028	7.61	9.11	1.50	0.46
3	2017	7294	16322	9.17	9.70	0.53	1.30
4	2018	7562	23884	9.73	10.08	0.35	1.99
5	2019	2012	25896	10.08	10.16	0.08	8.57
	Total	**30485**					

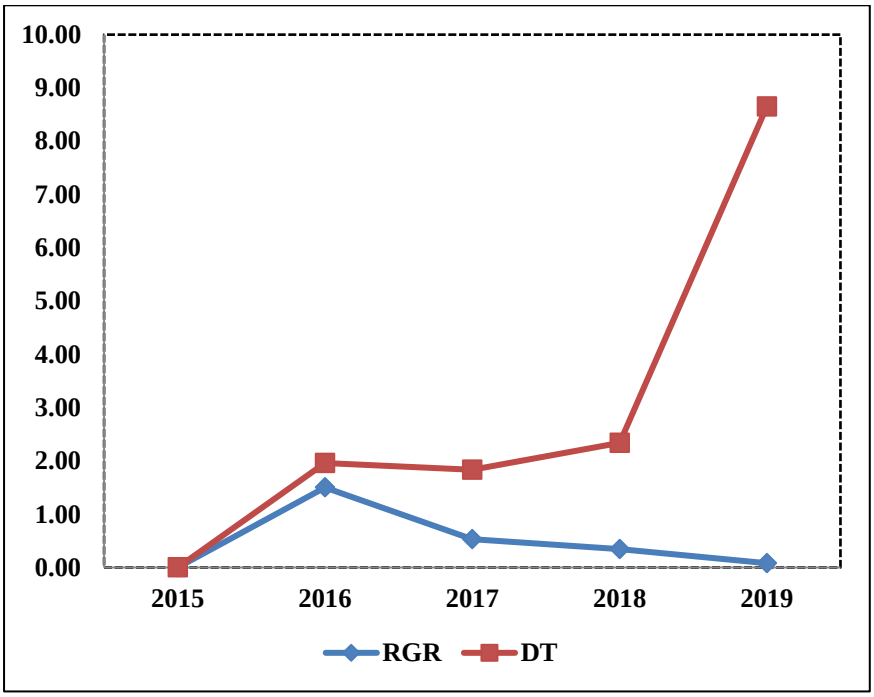

Figure-1: Relative growth rate and Doubling time

6.4 Geographical distribution of publications

Table 4 shows the distribution of most productive country's publications on gravity literature. It was revealed from the table that, from the China to Canada i.e. 10 countries contributed 66.76% of publications during the study period and among the countries China has stood in 1st place by producing 5567 publications with 18.26% followed by United State 4608 publications (15.12%) and India is in the 3rd rank by producing 1636 articles on gravity literature. The remaining 10 countries i.e. from Iran to Switzerland contributed only 15.88% of publications over the period of study. Remaining 17.36% of the publications published from the other countries which are not indicated in the table.

Table-4: Geographical distribution of records (Top 20)

Sl. No.	Country	No. of Records	Percentage
1	China	5567	18.26
2	United States	4608	15.12
3	India	1636	5.37
4	United Kingdom	1507	4.94
5	Germany	1447	4.75
6	Russia	1287	4.22
7	Italy	1183	3.88
8	Japan	1144	3.75
9	France	1071	3.51
10	Canada	901	2.96
11	Iran	868	2.85
12	Spain	672	2.20
13	Brazil	651	2.14
14	Korea	564	1.85
15	Netherlands	389	1.28
16	Australia	360	1.18
17	Turkey	342	1.12
18	Poland	339	1.11
19	Pakistan	333	1.09
20	Switzerland	324	1.06

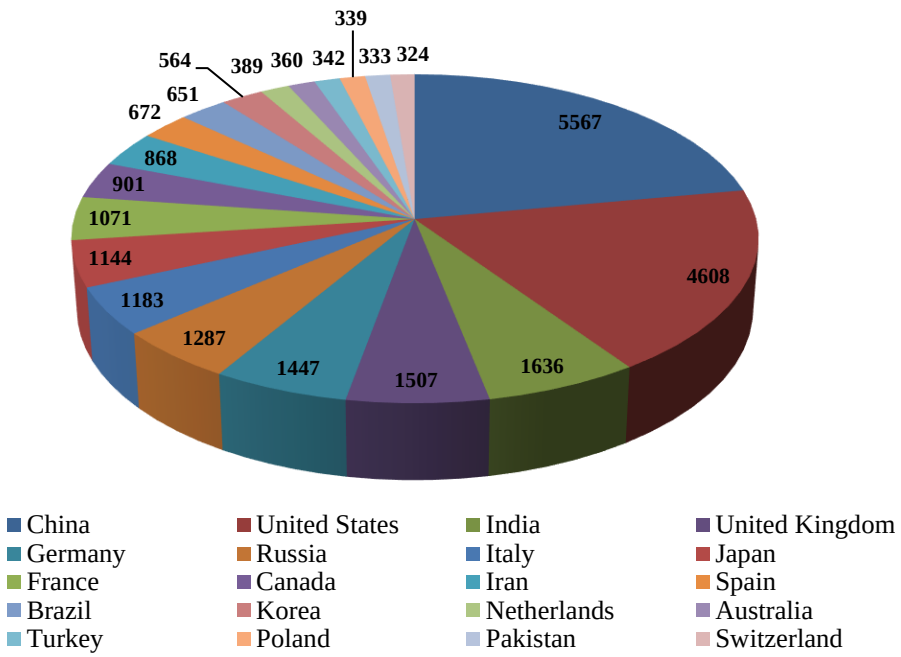

Figure – 2: Geographical distribution of records (Top 20)

6.5 Distribution of author affiliation

Table 5 presents the affiliation institutions of the author's in the field of gravity. To keep away from a long list, 20 most productive institutions taken for the study. It is clear from the table 5 that Perimeter Institute for Theoretical Physics, Waterloo, Ontario ranked in 1st place by contributing 189 (0.62%) publications in the field of gravity literature followed by Jet Propulsion Laboratory., California Institute of Technology., Pasadena, California is in 2nd rank with 179 (0.59%) publications and the Department of Mathematics., University of the Punjab, Lahore, India ranks third place in global level by producing with 125 (0.41%) publications on gravity literature. Remaining institutions are contributed less than 125 articles.

Table-5: Distribution of author affiliation institutions (Top 20)

Sl. No.	Author affiliation institutions	No. of Records	Percentage
1	Perimeter Institute for Theoretical Physics, Waterloo, Ontario	189	0.62
2	Jet Propulsion Laboratory., California Institute of Technology., Pasadena, California	179	0.59
3	Department of Mathematics., University of the Punjab, Lahore, India	125	0.41
4	School of Geodesy and Geomatics, Wuhan University., Wuhan	99	0.32
5	Department of Applied Mathematics and Theoretical Physics, University of Cambridge., Cambridge	98	0.32
6	Van Swinderen Institute for Particle Physics and Gravity., University of Groningen, Groningen	95	0.31
7	Department of Physics., Fudan University Shanghai	87	0.29
8	Yukawa Institute for Theoretical Physics., Kyoto University., Kyoto	85	0.28
9	Harvard-Smithsonian Center for Astrophysics., Cambridge, Ma	81	0.27
10	Institute of Cosmology and Gravitation., University of Portsmouth, Portsmouth	80	0.26
11	School of Mathematical Sciences., University of Nottingham, Nottingham	77	0.25
12	Instituto de Astrofísica de Canarias., La Laguna., Spain	74	0.24
13	Department of Physics and Astronomy., University of Waterloo, Waterloo, Ontario, Canada	69	0.23
14	Blackett Laboratory., Imperial College. London	68	0.22
15	Nasa Goddard Space Flight Center, Greenbelt, Md	67	0.22
16	Department of Physics., Durham University., Durham	66	0.22
17	Instituto de Física., Pontifical Catholic University of Valparaíso., Valparaiso	65	0.21
18	Departmento de Fisica., Universidade De Lisboa, Lisbon	65	0.21
19	Department of Physics., Montana State University., Bozeman, Mt	63	0.21

20	Department of Physics., University of California, Santa Barbara	61	0.2

6.6 Most prolific authors

The table 6 illustrates the top 20 most productive authors in the field of gravity literature over the years. The data consists of 20 authors with more than 36 articles each. It shows that Sharif, M is the most producing author contributing 94 articles followed by Capozziello, S.83 articles, Odintsov, S. D. 75 articles respectively. It is also found that the authors Chakraborty, S. and Kumar S. from India are ranked 5^{th} and 13^{th} by producing 64 and 41 articles respectively in the field of gravity literature.

Table-6: Most prolific authors (Top 20)

Sl. No.	Author	No. of Records	Percentage
1	Sharif, M.	94	0.31
2	Capozziello, S.	83	0.27
3	Odintsov, S. D.	75	0.25
4	Oikonomou, V. K.	68	0.22
5	Chakraborty, S.	64	0.21
6	Yunes, N.	54	0.18
7	Hendi, S. H.	52	0.17
8	Myrzakulov, R.	48	0.16
9	De, Laurentis M.	46	0.15
10	Koyama, K.	46	0.15
11	Saridakis, E. N.	42	0.14
12	Mann, R. B.	42	0.14
13	Kumar, S.	41	0.13
14	Heisenberg, L.	41	0.13
15	Tenzer, R.	40	0.13
16	Bambi, C.	39	0.13
17	Jawad, A.	39	0.13
18	Ferreira, P. G.	38	0.12
19	Baojiu, Li	37	0.12
20	Modesto, L.	37	0.12

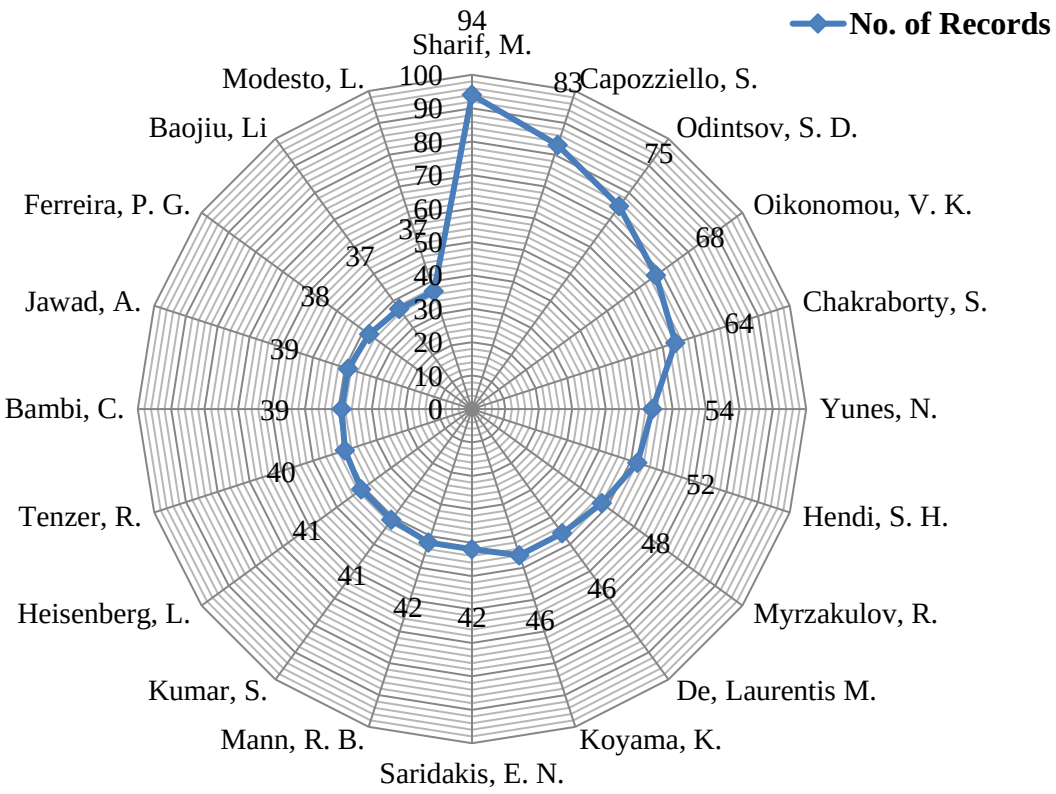

Figure-3: Most prolific authors

6.7 Language-wise distribution

Publication language was evaluated from 30485 documents during the study period. It is exhibit that the massive number of publications are in English (29599) followed by Chinese (814) and Russian (34). The remaining articles are extremely fewer in other languages such as Japanese, Kazakh, Korean, Italian and so on.

Table-7: Language-wise distribution of the literature

Sl. No.	Language	No. of Records	Percentage
1	English	29599	97.094
2	Chinese	814	2.670
3	Russian	34	0.112
4	Japanese	7	0.023
5	Kazakh	5	0.016
6	Korean	5	0.016
7	Italian	4	0.013
8	Polish	4	0.013
9	Turkish	3	0.010
10	Croatian	2	0.007
11	French	2	0.007

12	German	2	0.007
13	Spanish	2	0.007
14	Ukrainian	2	0.007
	Total	**30485**	**100**

6.8 Journal-wise distribution of records

The study found that majority of the researcher is preferred to publish their research articles in journals. The table 8 shows the top 20 most productive journals which have at least published 208 articles on gravity literature. The data reveals that Physical Review D journal (1852) is the largest contributor on gravity literature followed by Classical and Quantum Gravity (1770), Arxiv (1407). A total of 11770 articles are contributed in top 20 journals which are mentioned in the table 8 and the remaining journals are published less than 208 articles.

Table-8: Journal-wise distribution of records

Sl. No.	Journals	No. of Records	Percentage
1	Physical Review D	1852	6.08
2	Classical And Quantum Gravity	1770	5.81
3	Arxiv	1407	4.62
4	Journal of High Energy Physics	1175	3.85
5	European Physical Journal C - Particles And Fields	540	1.77
6	Journal of Physics: Conference Series	490	1.61
7	Physical Review D (Particles, Fields, Gravitation, And Cosmology)	480	1.57
8	Journal Of Cosmology And Astroparticle Physics	441	1.45
9	International Journal Of Modern Physics D	432	1.42
10	Astrophysical Journal	431	1.41
11	Proceedings Of The Spie	372	1.22
12	Monthly Notices Of The Royal Astronomical Society	366	1.20
13	Physics Letters B	341	1.12
14	Astronomy Astrophysics	292	0.96
15	Physical Review Letters	252	0.83
16	Journal Of Fluid Mechanics	252	0.83
17	AIP Conference Proceedings	232	0.76
18	Modern Physics Letters A	220	0.72
19	General Relativity And Gravitation	217	0.71
20	IOP Conference Series: Materials Science And Engineering	208	0.68

7 Conclusion

This study has evaluated 30485 publications on gravity literature indexed in INSPEC database during 2015 to 2019. The maximum number of publications 7562 was published in 2018. There is an increasing trend of publication from 2015 to 2018 and the highest number of articles is published in the form of journal articles. The relative growth rate is decreasing from 1.50 to 0.08 during 2016 to 2019 and doubling time is increasing from 0.46 in the year 2016 to 8.57 in 2018. The geographical distribution of publications shows China and USA is in the 1st and 2nd rank respectively. India has occupied 3rd rank by contributing 1636 publications on gravity literature. This shows the Indian scientists actively engaged in research on gravity. Another finding of the study is 189 publications are published from Perimeter Institute for Theoretical Physics, Waterloo, Ontario and it has in 1st position. Proudly Department of Mathematics., University of the Punjab, Lahore, India has got 3rd position by contributing 125 articles. So we can say that Indian institutions actively involved in research. In global level Sharif, M. is the most prolific author and the Indian authors Chakraborty, S. and Kumar S. are in 5th and 13th position respectively. Maximum number of articles is published in English language and Physical Review D is the most preferable journal by the researcher.

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