Scientometric Analysis of Gravity Research Output: A Global Perspective

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Abstract - *The main objective of this investigation is to know the applicability of Bradford's law in gravity research. A total of 75342 records has been retrieved from the Web of Science citation database for a period of 10 years i.e. from 2010 to 2019. The study examined the year-wise research output, communication channels preferred by the researchers, and most productive journals in gravity literature. The analysis of the study revealed that there is an increasing trend in terms of research productivity during the period. The maximum number of research papers are published in the year 2018 with 9407 records followed by 2019 with 9239 records and very less i.e. 5855 papers are recorded in the year 2010. The majority of the researchers prefer to publish their research articles in the form of journal articles. The rank list of most productive journals shows that Physical Review D is in 1st rank by contributing 5814 papers. The application of the Bradford law of scattering does not fit into the Bradford zones.*

Keywords: Scientometric, Gravity, Web of Science, Bradford Law, Bibliometrics

Introduction

Gravity could be a hidden force that pulls objects toward one another. Earth's gravity is what keeps you on the bottom and what builds things fall. In recent years gravity has a growing space of analysis in Physics all around the world and it's a sub-field in Astrophysics. Temimei and Hussein (2014) in his study expressed that "Gravity has performed a vital role within the investigation of forceful phenomena within the earth's interior". A gravity leads everybody will on earth we tend to alert to somehow operates and the way it influences human life. The gravity analysis is found between house and earth enlarged quickly within the nineteenth century. Gravity could be a force that raises articles in free fall (Kersting et al. 2020). Gravity identifies the pattern and action of every object within the house. All-stars and planets square measure rising at intervals monumental clouds of gas and mud referred to as nebulae. Stars and planets look once objects against this clouds square measure drawn against along by gravity. A gravitation theory is proof of the future forces like energetically impartial assembles use on one another as a result of being subject content. Since Sir patriarch Newton's law of motion of universal gravitation within the year the 1910s, 2 particulates attract along beneath main force comparative to the results of their plenty and reversely comparative to the sq. of the gap with one another, was united because of the acceptable and

whole theory of gravitation. The theory of core journals is originated from Bradford's Law of Scattering, that was developed by Samuel Clement Bradford in 1934. Bradford 1st printed his investigation of the rising scatter of connected journal articles on an explicit topic, and afterward, in 1948, printed this interpretation by relating the number of journals within the nuclear or most efficient zone, to the number of journals in consecutive less productive zones comprising equal numbers of papers. Among the many applied mathematics manifestations, Bradford's Law of Scattering is conceivably the foremost accepted and also the best recognized of all the bibliometric ideas that attempt to justify the precious operating of science by mathematical means that.

Literature Review

Several researchers applied scientometric studies in several subject areas within the world and national levels. Stewart et al (2012) studied whether or not Bradford's law was appropriate for the Cochrane Review–recognized literature on acute otitis media and respiratory illness, conditions that area unit reportable during a massive vary of clinical and health journals. The analysis disclosed that Bradford's law wasn't useful for predicting the scale of the literature on a subject matter from the number of articles showing in core journals. Wardikar and Gudadhe (2013) studied the scholar theses submitted to the University of Maharashtra to know the pertinence of Bradford law of scattering to the literature of Library and Information Science. The analysis showed that the journal distribution pattern in Library and Information Science theses doesn't match Bradford's distribution pattern. Singh and Bebi (2014), found that the journal Economic & Political Weekly is that the most cited journal with 22.8% citations, followed by The Punjab Past and Present with 1.80% citations. Bradford's law of scattering was applied and the result was positive. Venable et al (2014) applied William Bradford law to know the core journals of pediatric neurosurgery and a regional comparison of citation density. The result showed that regional comparison verified a priority for the Journal of Neurosurgery and Child's Nervous System, likewise, however, four of the highest 5 journals were regular to each team. Applying the verbal formulation of Bradford's law to the North American citation database, a pattern of citation density was recognized across the primary 3 zones. Velmurugan and Radhakrishnan (2015), identified a complete of 2802 research papers, out that 83.4% are journal articles and 99.7% were within the English language. In keeping with Australian researchers, the output of Environmental Sciences, Ecology (13.80%) account for the leading increase and it's taken within the 1st place and Energy Fuels (6.20%) is within the sixth place within the study. The 3 most extremely cited journals are Ecological Applications, Astrophysical Journal, Monthly Notes of the Royal Astronomical Society. It's consequent from the speculative aspects of Bradford's Law of Scattering and is tested and known. The quantitative relation shows that it doesn't match Bradford's law of distribution. Neelamma and Gavisiddappa (2016) analyzed the pertinence of the Bradford law of distribution within the field of Crystallography. The result showed that the Journal of Molecular Biology is that the most cited journal within the field of Crystallography and therefore the USA is the most cited country within the world. Bradford's law is well fitted into the given information set. A study made by Tripathi and Sen (2016) consisted of ten,100 papers indexed in Indian Science Abstracts and CAB Abstracts throughout the amount 1965-2010. The ranked lists of journals have been prepared and the Leimkuhler test was conducted. The data doesn't follow Bradford's law even with Leimkuhler's formulation. It combined information for 6 crops conjointly and cumulating of data in each fifth year deviated the dataset from Bradford law of scattering. Ramalingam and Elangovan (2017), studied law analysis students in their pH scale.D. a thesis submitted to completely different universities in the Republic of India, that area unit accessible in

Shodhganga digital repository. This study found 773 journals, containing 3187 citations collected from 252 scholar theses. It additionally lists the hierarchal list of core journals in law. The analysis applied for testing Bradford's law of scattering it's fit the studies. Kumar and Senthil Kumar (2018) analyzed a total of 18877 research papers published by Indian scientists within the field of Astronomy & Astrophysics throughout 1988-2017. The was identified the core journals in the Astronomy and Astrophysics field. The Bradford law of scattering and the Leimkuhler model was additionally tested to verify the data set. It had been disclosed from the study that it had been done not to prove the law of scattering similarly to the Leimkuhler model. The proportion of error was exceptionally high and therefore the value of multiplier factor 'k' is additionally variable from completely different zone to zone. Chaman Sab, Dharani Kumar, and Biradar (2018) study attempted to identify the applicability of Bradford law within the field of Indian Chemical science literature. The study showed that Bradford's law of scattering found to be of larger significance or core journals by applying Bradford's law on the data are found to be fit to the selected data. Savanur (2019) conducted a study on the application of Bradford's law of scattering to the Economics literature of India and China. The results of the study identified that the journal distribution pattern of the Economics literature published from India and China countries fit the Bradford distribution pattern during 1991-2016.

Objectives

- To verify Bradford's law of scattering to Gravity literature.
- To study the growth of Gravity research publications.
- To prepare highly productive source journals.

Methodology

The data was retrieved from the Web of Science citation database published by maintained by Clarivate Analytics. Data accessed with the help of an advanced search technique by using the term TS=(Gravity) and the period was selected from 2010 to 2019 i.e. for 10 years. A total of 75,342 was downloaded in CSV file format and text format for analysis. The data has been analyzed with the help of a Microsoft Excel spreadsheet and Histcite Software. The data has been presented in the form of tables and graphs for interpretation and discussion.

Analysis And Discussion

Year-wise Distribution of Records

The world publication productivity has shown fluctuation growth from 2010 to 2019. As reflected in the Web of Science database a total of 75342 records has been published in Gravity research. The highest number of publications 9407 (12.26%) articles are published in the year 2018 followed by 9239 publications (12.26%) in 2019 and 8539 publications (11.33%) in 2015. The lowest number of publications 5855 (7.77%) are published in 2010. The growth of literature is in fluctuation during the study.

Table-1: Year-wise Distribution of Records

Years	Records	Percentage
2010	5855	7.77
2011	6210	8.24
2012	6728	8.93
2013	7092	9.41
2014	6437	8.54
2015	8539	11.33
2016	7831	10.39
2017	8004	10.62
2018	9407	12.49
2019	9239	12.26
Total	**75342**	**100**

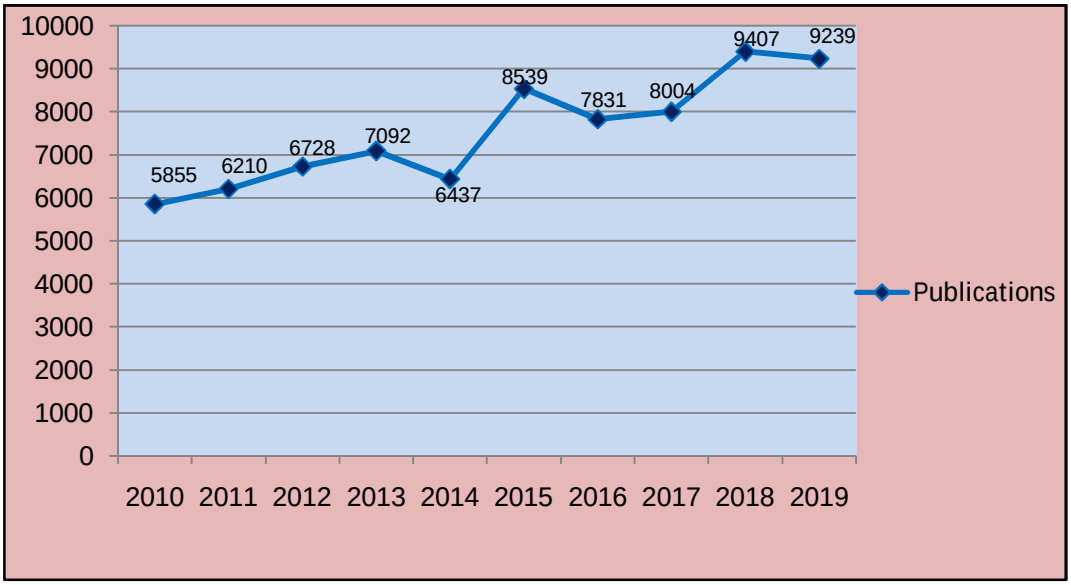

Figure 1: Year-wise Distribution of Gravity Research Output

Distribution of Records by Document Type

Table 2 indicates the distribution of records in different types of documents in the field of gravity. The highest number of records are published in the form of articles, which produce 71108 (94.38%) and are categorized as an essential basic resource of information. It is followed by Reviews (2.27%) and Proceeding Papers (1.86%) is contributed 1784 and 1403 respectively. Articles, reviews, and proceeding papers collectively facilitate 98.61% of the overall research outcome, and the remaining 1.39% of papers are isolated as Editorial material, meeting abstract, correction, etc.

Table - 2: Distribution of Records by Document Type

Document Types	Records	Percentage
Article	71108	94.38
Proceedings Paper	1403	1.86
Book Review	24	0.03
Correction	187	0.25
Editorial Material	373	0.50
Letter	102	0.14

Meeting Abstract	222	0.29
News Item	60	0.08
Reprint	4	0.01
Review	1784	2.37
Review; Book Chapter	75	0.10
Total	**75342**	**100**

Subject Areas of Research

The entire publication in the gravity field has been divided into many sub-disciplines. Table 3 shows the top 10 subject areas in the field of gravity. The research outputs in the top 10 sub research areas differ from 2525 to 19952 records. The evaluation of gravity research contribution indicates that 26.48 percent (19952) of the total records are published in Astronomy Astrophysics, consequently Physics Particles Fields 24.97 percent of share and 18812 publications) and Physics Multidisciplinary (9.74 percent share and 7339 publications). The remaining papers are published in other sub research areas.

Table - 3: Subject areas in Gravity Research (Top 10)

Subject Areas	Records	Percentage
Astronomy Astrophysics	19952	26.48
Physics Particles Fields	18812	24.97
Physics Multidisciplinary	7339	9.74
Geosciences Multidisciplinary	5561	7.38
Geochemistry Geophysics	5032	6.68
Mechanics	4285	5.69
Meteorology Atmospheric Sciences	3277	4.35
Physics Fluids Plasmas	2632	3.49
Physics Mathematical	2562	3.40
Engineering Chemical	2525	3.35

Top-Ranked Journals in Gravity Subject

The rank list of journals on gravity research during the period of study is shown in Table 4. The analysis of the data for the dissemination of gravity research output predicts that among the top 10 journals all are of foreign origin and most journals are published by the USA and UK. The data shows that Physical review D, USA is in the first rank with the maximum number of papers of 5814 (7.71%) followed by Journal of High Energy Physics, Switzerland with 4360 publications (5.79%) and Journal of cosmology and astroparticle physics, the UK with 1680 publications (2.22%). None of the Indian journals not occupied in the top 10 journals list.

Table - 4: Top-Ranked Journals in Gravity Subject

Name of journal	Country	Publisher	Rank	Records	Impact factor	h-index
Physical Review D	USA	American Physical Society	1	5814	4.368	101
Journal of High Energy Physics	Switzerland	Springer	2	4360	5.833	107
Journal of Cosmology and Astroparticle Physics	UK	IOP Publishing	3	1680	5.524	70

Classical and Quantum Gravity	UK	IOP Publishing	4	1675	3.487	61
Monthly Notices of the Royal Astronomical Society	UK	Oxford university press	5	1452	5.231	76
Physics Letters B	Netherlands	Elsevier	6	1176	4.162	62
European Physical Journal C	Switzerland	Springer	7	1174	4.843	45
Astrophysical Journal	USA	American astronomical Society.	8	1073	5.580	79
Journal of Fluid Mechanics	UK	Cambridge university press	9	992	3.137	43
International Journal of Modern Physics D	Singapore	World Scientific Publishing Co Pvt Ltd	10	921	2.004	35

Application of Bradford's Law

Bradford's law of scattering is constituted on the rule that each scientific and systematic subject area is related. S.C. Bradford (1934) suggested scattering of scientific productivity as a standard of central output zones with a reducing information consistency. In another term every zone or core includes a related number of research articles, however, the number of journals in which these are published increases from one zone to the next according to the expression $1:n:n^2$, in this manner, a set of journals devoted increasingly particularly to the subject of focus can be renowned. The Bradford law of scattering says that if a high number of articles are placed in the sequence of declining output of journals related to the provided can be highlighted so that every zone originates 1/3rd of the overall appropriate pages (Zafrunnisha, 2012).

In this study, a total of 4965 journals are distributed within three zones for examining the numerical analysis. "The Bradford's multiplier factor was happened by splitting periodical titles of a zone by its previous zone" (Chaman Sab, Dharani Kumar and Biradar, 2018). The scattering of journals and the equivalent number of articles in the three zones along with the value of Bradford multipliers are indicated in Table-5

From the current data, nineteen journals include 25232 articles, the next 236 journals contain 25093 articles and further 4710 journals contain 25017 articles. According to Bradford's law of scattering, the zones consequently recognized will appearance an almost mathematical sequence in the manner 1: n: n^2. It is identified that the correlation of every zone in the current study is 19:236:4710. Hence the analysis of the study reveals that Bradford's law does not fit into Bradford's law of distribution.

Here, 19 represent the number of journals in the nucleus, and n=22.40 is the multiplier, the mean value of the multiplier is 22.40

Therefore, 19: 19x22.40: $19x22.40^2$:1: n: n^2
19:425.6:9533.44>>9978.04

The percentage error =

$$\frac{9978.04 - 4965}{4965} \times 100$$

Percentage error = 100.97

Since the percentage error is high, the data will not fit well the Bradford's Law of Scattering.

Table 5: Scattering of Journals and Articles over Bradford Zone

Zones	No. of Journals	Percentage of journals	No. of articles	Percentage of articles	Multiplier
1	19	0.38	25232	33.49	
2	236	4.75	25093	33.31	12.42
3	4710	94.86	25017	33.20	19.96
Total	4965	100	75342	100	22.40

Findings and Conclusion

The study found that the highest (12.49%) number of papers published in the year and the lowest (7.77%) of papers were published in the year 2010 during the period of study. The largest (94.38%) of records published in the form of articles and book reviews, news items, reprint are the less medium of communication. This shows most of the researchers prefer to publish their research work in the form of articles. In terms of the subject-wise distribution of records shows that 26.48% of the research papers published in Astronomy Astrophysics subject followed by Physics Particles Fields with 24.97% papers. In among ranking of most preferred journals by the researchers, the first rank goes to Physical review D published by American Physical Society, the USA with 5814 papers followed by the Journal of High Energy Physics published by Springer, Switzerland occupied in second place with 4360 papers. Bradford's law of scattering of journal groups into 3 zones. A small group i.e. 19 journals has 25232 papers followed by 236 journals has 25093 papers and 4710 journals have 25017 papers. The application of Bradford's law does not fit into Bradford's law of distribution.

References

1. Bradford, S. C. 1934. "Sources of information on specific subjects". *Engineering*., 1934, 10(4), 85-86.
2. Chaman Sab M, P. Dharani Kumar & B.S. Biradar. 2018. "Bradford's Law: Identification of the Core Journals in the Field of Indian Chemical Science Literature". *International Journal of Information Dissemination & Technology*., 8(2), 104-110.
3. Kersting, M., Toellner, R., Blair, D., & Burman, R. 2020. "Gravity & warped time-clarifying conceptual confusions in general relativity". *Physics Education*., 55(1), 1-12.
4. Kumar, S., & Senthilkumar, R. 2018. "Application of Bradford's law of scattering on research publication in Astronomy & Astrophysics of India". *Library Philosophy and Practice*, 1.
5. Nash-Stewart, C. E., Kruesi, L. M., & Del Mar, C. B. 2012. "Does Bradford's Law of Scattering predict the size of the literature in Cochrane Reviews?". *Journal of the Medical Library Association: JMLA*, 100(2), 135.

6. Neelamma, G. & Anandhalli, G. 2016. "Application of Bradford's law in the field of crystallography: A scientometric study". *International Journal of Information Dissemination and Technology*, 6(2), 77-83.
7. Ramalingam, Jayshankar and Elangovan, Nishavathi. 2017. "Application of Bradford's law of Scattering to the discipline of law: Analysis of Doctoral Thesis Citations submitted by Universities in India". *Library and Philosophy and Practices (E-Journal)*, 1621.
8. Savanur, K. P. 2019. "Application of Bradford's Law of Scattering to the Economics Literature of India and China: A Comparative Study". *Asian Journal of Information Science & Technology (AJIST)*, 9(1).
9. Singh, K P and Bebi 2014. "Application of Bradford's Law on journal citations: A study of Ph.D. theses in social sciences of University of Delhi". *Annals of Library and Information Studies*, 61(2), 112-120.
10. Temimei, Faeq A. AL & Hussein A. Alshamarti. 2014. "The earth gravity between regions of Najaf & Kufa city in Iraq". *British Journal of Earth Sciences Research.*, 2(1), 19-23.
11. Tripathi, Harish Kumar and Sen, B.K. 2016. "Crop science literature and Bradford law". *Annals of Library and Information Studies*, 63(2),85-90.
12. Velmurugan and Radhakrishnan. 2015. "Application of Bradford's Law of Scattering to the Scientific Publications of Energy and Environment Research". *Engineering International*, 3(2), 75-86.
13. Venable, G. T., Shepherd, B. A., Roberts, M. L., Taylor, D. R., Khan, N. R., & Klimo, P. 2014. "An application of Bradford's law: identification of the core journals of pediatric neurosurgery and a regional comparison of citation density". *Child's Nervous System*, 30(10), 1717-1727.
14. Wardikar, V. G., & Gudadhe, V. P. 2013. "Application of Bradford's Law of Scattering to the Literature of Library & Information Science: A Study of Doctoral Theses Citations Submitted to the Universities of Maharashtra, India". *Library Philosophy and Practice*, 1.
15. Zafrunnisha, N. 2012. "Bradford's zones & productivity of journals in psychology doctoral theses". *Annals of Library & Information Studies.*, 59(1), 39-52.