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Applicability of Lotka's Law in Astronomy & Astrophysics Research of India

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Abstract: *The paper reveals the scientific productivity pattern of authors in the field of Astronomy & Astrophysics research in India and applicability of Lotka's law in the literature of Astronomy & Astrophysics for the given data set. Data was retrieved from WoS database for this study, a total of 6,363 papers has been published by 2,719 authors during 2013-2017 in straight count of the authorship. Examining the Lotka's Inverse square (n=2) method as well as general power method (n≠2), (calculating the value of 'n' with observed data) was used to test the applicability of Lotka's law. Goodness of fit test - Chi-Square test and Kolmogorov-Smirnov (K-S) test was also used to measure the viability of Lotka's law in the field of Astronomy & Astrophysics research in India. The productivity distribution didn't fit when Lotka's law was applied in generalized form as well as in its original form on the data set. This confirms that Lotka's law doesn't fit to the literature of Astronomy & Astrophysics.*

Key words: Lotka's Law, Astronomy & Astrophysics, Straight Counting Method, Chi-Square test, Kolmogorov-Smirnov (K-S) test, India.

1. Introduction

Research productivity of an individual, organization or a country has been measured using the different parameters by the researchers from time to time. The classical laws of Bibliometrics which was given by three different learned information professionals are the key laws and practically used as tool to judge a specific subject arena in different prospects. The classical laws are the pillar of bibliometric or scientometric studies: 'Bradford's law of scattering'[1] (scattering of publication); 'Lotka's law of Scientific Productivity'[2] (author's productivity in a subject); and 'Zipf's Law of Word's Occurrence'[3] (ranking of the word's frequency in a literature). 'Lotka's Law of scientific productivity' is the law of bibliometrics which is used to map the productivity pattern of authors in a subject.

In 1926, Alfred J. Lotka published a classic paper on his study about the frequency distribution of scientific productivity of authors observing the publications listed in Chemical Abstracts for the period 1907-16. The law states, "…the number (of authors) making 'n' contributions is about $1/n^2$ of those making one; and the proportion of all the authors that make a single contribution is of about 60 percent…."[2]. It means that in a subject or discipline, 60 % of the authors produces one publication; 15 % produces two publications ($1/2^2 * 60$); 7 percent produces three publications ($1/3^2 * 60$), and so on. The law is a generalized approach to map the authorship rather than a rigid law, and varies field to field but it gives a broader prospect to know the productivity pattern of authors in a discipline.

Lotka's law can be articulated in the following equation as

$$x^n * y = \mathbf{C} \qquad \text{-------------------- (1)}$$

Where '*x'* is the number of articles published (1, 2, 3, 4….); '*y'* is the number of authors with frequency '*x'* number of articles; '*n'* is an exponent that is constant for a given set of data; and '*C'* is a constant.

When n=2 used for a data set then the law is called *'Inverse square law of scientific productivity'*, In this case the value of constant 'C'=0.6079. The value of 'n' differs from data set to data set. In the present study, Linear Least Square (LLS) method has been used to calculate the value of 'n' defined by Pao[4]. It can be articulated as:

$$\mathbf{n} = \frac{N \sum XY - \sum X \sum Y}{N \sum X^2 - (\sum X)^2} \qquad \text{-------------------- (2)}$$

Where, '*X'* is the logarithm value of '*x*' i.e. number of publications; '*Y'* is the logarithm value of '*y' i.e.* number of authors and '*N'* is the number of data pairs available for the study.

The constant '*C'* can be calculated by the follows equation:

$$\mathbf{C} = \frac{1}{\sum 1/x^n} \qquad \text{------------------------ (3)}$$

To examine the observed frequency pattern of author's productivity suits the expected frequency pattern; Pao[9] advised applying the non-parametric Kolmolgorov- Smirnov (K-S) goodness-of-fit test. To check it, the highest deviation between the observed cumulative relative frequency and expected cumulative relative frequencies needs to be considered, and then compared it with the critical value (C.V.) which can be calculated by the following equation determined by Nicholls[5-6]
:

$$\textbf{Critical Value (C.V.)} = \frac{1.63}{[\sum y_x + (\sum y_x / 10)^{1/2}]^{1/2}} \qquad \text{---------------------- (4)}$$

2. Review of Literature

Vlachy[7] stated that Lotka's law was unseen for a long time until 1978, a bibliography of 437 publications on Lotka's Law and its similar statistical regularities shown in 'Scientometrics' Journal. Ever since, this law has been verified & tested over different subject's data set to witness the frequency distribution of author and publications. In 1963, Price[8] also gave a similar law of productivity, inspired from Alfred J. Lotka's law and stated, "Half of the scientific papers are contributed by the square root of the total number of scientific authors". This law is called 'Price Square Root Law of Scientific Productivity'. Pao[9] studies the fitness of Lotka's law applying least square method (LLS) with 48 data sets in different subjects to test the author's scientific productivity. Gupta[10] studies the entomological research in Nigeria during 1900-1973, a total of 1720 papers were analyzed to study the author's productivity pattern and to test the applicability of Lotka's on four different sets of data and found that the law in its original form does not apply to any of the data sets as an 'Inverse Square Law'. Schorr[11] conducted a research to verify the applicability of Lotka's law on 618 publications in two journals of library science during the period 1963-1972 and found that Lotka's law doesn't fit to the literature of library science. Radhakrishnan and Kernizan[12] in his research found that Lotka's Law in its broader approach seems applicable in publication of authors in one journal whereas when it was measured for the publications of authors in various journals, the observed values diverge very much from the predicted value. Patra, Bhattachraya, and Verma[13] carried out a research on bibliometrics literature taken from the Library and Information Science Abstract (LISA). A total of 3781 records for the period 1969- 2005 were analised and found that the Kolmogorov-Smirnov test doesn't support the bibliometrics literature data set to the follow Lotka's law. Kumar[14] verified the viability of Lotka's Law as an inverse square power as well as general inverse power and link to the research publications of CSIR, India for the two datasets of publications (6076 and 17681) for the periods of 1988-1992 & 2004-2008 respectively. Kolmogorov-Smimov goodness-of-fit tests was conducted to determine the degree of significance between the frequencies of the observed set of data with excepted data, and established that Lotka's inverse square law didn't fit to confirm. Patra and Chand[15] considered 3,396 publications data containing author's affiliation from "India" in the online version of LISA and after analysis, it was concluded that the value of the power 'n' to be 2.12 and the constant 'c' is 0.64; the results of the Kolmogorov-Smirnov test shown the fitness of data set for the Lotka's law of productivity. Sevukan and Sharma[16] studied the biotechnology research in central universities of India and obtained the values of n = 2.12, C = 0.669, and D = 0.027 using least square method for appropriateness of Lotka's law. Ahmed and Rahman[17] examined the publication of nutrition research in Bangladesh during 1972-2006. Lotka's law was tested using generalized as well as modified form; Kolmogorov-Smimov goodness-of-fit tests were also verified. It was found that generalized inverse square form of Lotka's doesn't fit but using linear least-squares (LLS) excluding prolific authors and maximum likelihood methods, Lotka's law found to be fit to nutrition research of Bangladesh. Suresh Kumar[18] verified the authorship frequency distribution on 2106 publications references of the Journal of Documentation published during 2003-2015 using K-S test and conculded that Lotka's law fit to the data set of LIS literature.

A number of studies have been done so far in difference subjects with various prospects to test the feasibility of lotka's law in the frequency distribution of authors in publications. Applicability of Lotka's law has never been tested by the researchers in the field of Astronomy & Astrophysics yet. The present study is aimed to verify the suitability of Lotka's law in Astronomy & Astrophysics research literature of India.

3. Objectives:

Following are the objectives of the present study:

1. To investigate the authors scientific productivity pattern in the field of Astronomy & Astrophysics of India.
2. To verify the Lotka's Law in its generalized form as well as in inverse square form in the field of Astronomy & Astrophysics.
3. To inspect the validity of Lotka's law using Authors straight count method.
4. To apply the non-parametric 'Kolmolgorov- Smirnov (K-S)' and 'Chi-square' test of 'Goodness-of-Fit test' for the conformity of the Lotka's law.

5. Methodology and Data Source

Egge[19] gave four methods for counting of author's distribution in publication- 'Total counting method': An author's every presence is given an equal importance; 'Proportional counting method': an author gets proportionally weightage as per his position (rank) in the authorship; 'Fractional counting method': an author be given fractional recognition and 'Straight counting method': only the first authorship is counted.

Data for the present study was retrieved from the Web of Science[20] (WoS) bibliographical Database. A total of 6, 363 papers has been published by 2,719 authors during 2013-2017 was counted in 'straight count of the authorship method' using 'Bibliomatrix' and 'Excel' software. Goodness-of-fit test was done using Kolmolgorov- Smirnov (K-S)' and 'Chi-square' test for the conformity of the applicability of Lotka's law in the present data set.

6. Goodness-of-Fit Tests

There are many goodness- of- fit tests are available for conformity and testing the validity of data. Kolmogrov-Smirnov (K-S) test and Chi-square test are frequently applied as goodness-of-fit apparatus.

(i) K-S Test

K-S test is carried out by calculating the theoretical and observed cumulative frequency distribution of authors. The difference at each level of cumulative frequency distribution is counted. The maximum difference (D_{max}) is observed and further it is compared with the critical value calculated using equation no. (4). If the difference is less than critical value, it is accepted otherwise rejected.

(ii) **Chi-square Test**

In a data set, observations comes into definite specific categories, it can be identified whether the observed frequencies differs considerably from the predicted frequencies on the basis of a definite hypotheses or not. If it varies significantly, the null hypothesis may get failed.

7. Analysis and Discussions

7.1 General Power Method (n≠2)

7.1.1 Determining the value of 'n', 'C' and C.V.

The Lotka's Law reveals the productivity frequency distribution of authors in a given subject/discipline. In this paper, an attempt has been made to study the applicability of the Lotka's Law to the publications of India in the subject- Astronomy & Astrophysics. To test the applicability, the value of 'n', 'C' and 'Critical value' of the data set has been determined with the help calculations made in the table 01 shown below.

S. N.	No. of Publication (*x*)	No. of Author (*y*)	X (Log *x*)	Y (Log *y*)	X^2	X*Y	x^n	$1/x^n$
1.	1	1554	0	7.348588	0	0	1	1
2.	2	527	0.693147	6.267201	0.480453	4.344092	3.630077	0.275476
3.	3	243	1.098612	5.493061	1.206949	6.034745	7.716947	0.129585
4.	4	115	1.386294	4.744932	1.921812	6.577873	13.17746	0.075887
5.	5	76	1.609438	4.330733	2.59029	6.970046	19.95649	0.050109
6.	6	70	1.791759	4.248495	3.210402	7.612282	28.01311	0.035698
7.	7	36	1.945910	3.583519	3.786566	6.973206	37.31491	0.026799
8.	8	27	2.079441	3.295837	4.324077	6.8535	47.83518	0.020905
9.	9	18	2.197224	2.890372	4.827796	6.350796	59.55128	0.016792
10.	10	9	2.302585	2.197225	5.301898	5.059297	72.4436	0.013804
11.	11	8	2.397895	2.079442	5.749902	4.986283	86.49488	0.011561
12.	12	7	2.484907	1.94591	6.174761	4.835405	101.6897	0.009834
13.	13	2	2.564949	0.693147	6.578965	1.777887	118.0143	0.008474
14.	14	5	2.639057	1.609438	6.964624	4.247399	135.456	0.007382

15.	15	1	2.708050	0	7.333536	0	154.0032	0.006493
16.	17	3	2.833213	1.098612	8.027098	3.112603	194.3726	0.005145
17.	19	1	2.944439	0	8.669721	0	239.0461	0.004183
18.	20	1	2.995732	0	8.974412	0	262.9758	0.003803
19.	21	1	3.044522	0	9.269117	0	287.9572	0.003473
20.	22	2	3.091042	0.693147	9.554543	2.142547	313.983	0.003185
21.	23	1	3.135494	0	9.831324	0	341.0466	0.002932
22.	26	1	3.258096	0	10.61519	0	428.401	0.002334
23.	28	2	3.332204	0.693147	11.10359	2.309708	491.7155	0.002034
24.	35	1	3.555348	0	12.6405	0	744.6746	0.001343
25.	37	1	3.610918	0	13.03873	0	825.7626	0.001211
26.	38	1	3.637586	0	13.23203	0	867.7557	0.001152
27.	50	1	3.912023	0	15.30392	0	1445.72	0.000692
28.	52	1	3.951244	0	15.61233	0	1555.128	0.000643
29.	56	1	4.025352	0	16.20346	0	1784.965	0.00056
30.	58	1	4.060443	0	16.4872	0	1905.356	0.000525
31.	67	1	4.204693	0	17.67944	0	2491.719	0.000401
32.	110	1	4.700480	0	22.09452	0	6266	0.00016
Total		**2719**	**88.192103**	**53.21281**	**278.7891**	**80.18767**	**21332.88**	**1.722575**

Table: 01

The value of ‘n’ can be calculated using the equation no. (2) and Table 01 as discussed above,

$$n = \frac{N \sum XY - \sum X \sum Y}{N \sum X^2 - (\sum X)^2}$$

$$= \frac{32*80.18767 - 88.192103*53.21281}{32*278.7891-(88.192103)^2} = \mathbf{1.86}$$

Using the value of ‘n’, the value of ‘C’ can be calculated with the help of equation no. (3) and Table 01 as shown below:

C= 1 / 1.722575 = **0.58**

Again, the Critical Value (C.V.) can be determined with equation no. (4),

$$\text{Critical Value (C.V.)} = \frac{1.63}{[2719 + (2719)^{1/2}]^{1/2}} = \mathbf{0.0311}$$

7.1.2 Kolmolgorov-Smirnov (K-S) Test (n=1.86)

The K-S goodness-of-fit test is used to test the fitness of Lotka's law on observed frequency of authors in comparing with expected frequency of authors productivity. Looking at the seventh column in Table 02, the maximum deviation between the cumulative distributions was found, D_{max} = 0.041216 which is more than the critical value observed i.e. C.V. = 0.0311. Hence, it can be affirmed, the K-S test reveals that the present data set doesn't confirm the applicability of Lotka's Law in the field of Astronomy & Astrophysics research in India.

Publication (*x*)	**Author (*y*)**	**Observed Authors**		**Expected Authors**		**Deviation (Fo-Fe)**
		Relative %	**Cumulative % (Fo)**	**Relative %**	**Cumulative % (Fe)**	
1	1554	0.571534	0.571534	0.5805	0.5805	-0.00897
2	527	0.193821	0.765355258	0.15991398	0.740414	0.024941
3	243	0.089371	0.85472635	0.075224046	0.815638	0.039088
4	115	0.042295	0.897021312	0.044052508	0.859691	0.037331
5	76	0.027951	0.924972764	0.029088278	0.888779	0.036194
6	70	0.025745	0.950717523	0.02072244	0.909501	**0.041216**
7	36	0.01324	0.963957685	0.015556786	0.925058	0.0389
8	27	0.00993	0.973887807	0.012135421	0.937193	0.036694
9	18	0.00662	0.980507887	0.009747902	0.946941	0.033567
10	9	0.00331	0.983817928	0.008013131	0.954954	0.028863
11	8	0.002942	0.986760186	0.00671138	0.961666	0.025094
12	7	0.002574	0.989334662	0.005708541	0.967374	0.02196
13	2	0.000736	0.990070227	0.004918895	0.972293	0.017777
14	5	0.001839	0.991909138	0.004285525	0.976579	0.01533
15	1	0.000368	0.99227692	0.003769402	0.980348	0.011929
17	3	0.001103	0.993380267	0.002986532	0.983335	0.010045
19	1	0.000368	0.993748049	0.002428402	0.985763	0.007985
20	1	0.000368	0.994115832	0.002207427	0.987971	0.006145
21	1	0.000368	0.994483614	0.002015925	0.989987	0.004497
22	2	0.000736	0.995219178	0.001848826	0.991835	0.003384
23	1	0.000368	0.995586961	0.001702113	0.993537	0.002049
26	1	0.000368	0.995954743	0.001355039	0.994893	0.001062
28	2	0.000736	0.996690307	0.001180561	0.996073	0.000617
35	1	0.000368	0.99705809	0.000779535	0.996853	0.000205
37	1	0.000368	0.997425872	0.000702987	0.997556	-0.00013
38	1	0.000368	0.997793654	0.000668967	0.998225	-0.00043
50	1	0.000368	0.998161437	0.00040153	0.998626	-0.00046
52	1	0.000368	0.998529219	0.000373281	0.998999	-0.00047

56	1	0.000368	0.998897001	0.000325216	0.999325	-0.00043
58	1	0.000368	0.999264783	0.000304668	0.999629	-0.00036
67	1	0.000368	0.999632566	0.000232972	0.999862	-0.00023
110	1	0.000368	1.000000348	0.000092642	0.999955	0.00045
Total	**2719**			**0.99995486**		

Table: 02

7.1.3 Chi-Square Test (n=1.86)

To verify whether the author's productivity frequency affirms the Lotka’s law or not, the Chi-square-goodness-of-fit test is applied to the data set. The results of the examination are organized and shown in Table 03. The calculated value of chi-square in this data set is 98.39 and the theoretical critical value of chi-square at 0.05 level of significance is 46.19. The obtained value of Chi-square is greater than the theoretical value of chi-square. Hence, it can be concluded that the Lotka’s law doesn’t suits the literature of the Astronomy & Astrophysics.

Publication(x)	**Observed frequency of Authors (Fi)**	**Expected frequency of Author (Pi)**	$Fi – Pi$	$(Fi – Pi)^2$	$(Fi – Pi)^2 / Pi$
1	1554	1578	-24	576	0.365019011
2	527	435	92	8464	19.45747126
3	243	205	38	1444	7.043902439
4	115	120	-5	25	0.208333333
5	76	79	-3	9	0.113924051
6	70	56	14	196	3.5
7	36	42	-6	36	0.857142857
8	27	33	-6	36	1.090909091
9	18	27	-9	81	3
10	9	22	-13	169	7.681818182
11	8	18	-10	100	5.555555556
12	7	16	-9	81	5.0625
13	2	13	-11	121	9.307692308
14	5	12	-7	49	4.083333333
15	1	10	-9	81	8.1
17	3	8	-5	25	3.125
19	1	7	-6	36	5.142857143
20	1	6	-5	25	4.166666667
21	1	5	-4	16	3.2
22	2	4	-2	4	1
23	1	4	-3	9	2.25

26	1	4	-3	9	2.25
28	2	3	-1	1	0.333333333
35	1	2	-1	1	0.5
37	1	2	-1	1	0.5
38	1	2	-1	1	0.5
50	1	1	0	0	0
52	1	1	0	0	0
56	1	1	0	0	0
58	1	1	0	0	0
67	1	1	0	0	0
110	1	1	0	0	0
	2719	2719	**Chi-Square (χ^2)**		**98.39545857**

Table: 03

7.2 Square Power Method or Inverse Square Method (n=2)

Initially, Alfred J. Lotka tested the data of his study with the value of n=2 and formulated the Lotka's Law. The law was initially known as 'Lotka's Inverse square law of scientific productivity'. Many of the earlier researchers have also tested the applicability of this law in various subject fields. Theoretically, the value of the constant 'C' has been given 0.6079 for the value of exponent 'n'=2. The Inverse Square test has been attempted to verify the present data set predictability and K-S test & Chi-Square goodness-of-fit test has been verified to confirm the applicability of the law.

7.2.1 Calculating the Deviation for Kolmolgorov- Smirnov (K-S) Test (n=2 & C=0.6079)

No. of Publication (x)	Observed			Expected			Deviation (F_e-F_o)
	Frequency of Authors (y_x)	Cum. frequency of Authors	Relative frequency of Authors (F_o)	Frequency of Authors (y_e)	Cum. frequency of Authors	Relative frequency of Authors (F_e)	
1	1554	1554	0.5715	1653	1653	0.6244	-0.0529
2	527	2081	0.7653	413	2066	0.7805	-0.0152
3	243	2324	0.8547	184	2250	0.8500	0.0047
4	115	2439	0.8970	103	2363	0.8927	0.0043
5	76	2515	0.9249	66	2419	0.9139	0.011
6	70	2585	0.9507	46	2465	0.9132	**0.0375**
7	36	2621	0.9639	34	2499	0.9441	0.0198

8	27	2648	0.9739	26	2525	0.9539	0.02
9	18	2666	0.9805	20	2545	0.9615	0.019
10	9	2675	0.9838	17	2562	0.9679	0.0159
11	8	2683	0.9868	14	2576	0.9732	0.0136
12	7	2690	0.9893	11	2587	0.9773	0.012
13	2	2692	0.9901	10	2597	0.9811	0.009
14	5	2697	0.9919	8	2605	0.9841	0.0078
15	1	2698	0.9923	7	2612	0.9868	0.0055
17	3	2701	0.9934	6	2618	0.9890	0.0044
19	1	2702	0.9937	5	2623	0.9909	0.0028
20	1	2703	0.9941	4	2627	0.9924	0.0017
21	1	2704	0.9945	4	2631	0.9939	0.0006
22	2	2706	0.9952	3	2634	0.9951	0.0001
23	1	2707	0.9956	3	2637	0.9962	-0.0006
26	1	2708	0.9959	2	2639	0.9970	-0.0011
28	2	2710	0.9967	2	2641	0.9977	-0.001
35	1	2711	0.9971	1	2642	0.9981	-0.001
37	1	2712	0.9974	1	2643	0.9985	-0.0011
38	1	2713	0.9978	1	2644	0.9989	-0.0011
50	1	2714	0.9982	1	2645	0.9992	-0.001
52	1	2715	0.9985	1	2646	0.9996	-0.0011
56	1	2716	0.9989	1	2647	1	-0.0011
58	1	2717	0.9993	0	2647	1	-0.0007
67	1	2718	0.9996	0	2647	1	-0.0004
110	1	2719	1	0	2647	1	0
Total	2719			2647			

Table: 04

To verify the K-S goodness-of-fit test with exponent n=2 in terms of author's productivity pattern in the present data set, the observed and expected authors frequency relativity was calculated and tabulated in the Table 04 and the maximum deviation was counted, D_{max} =0.0375. The calculated significance of critical value is 0.0311. Comparing the D_{max} with critical value, it is observed that the difference in the observed and expected author's distribution pattern is higher than the critical value which reflects that the K-S goodness-of-fit test fails to support the applicability of Lotka's law in the present data set.

7.2.2 Chi-Square Test (n=2)

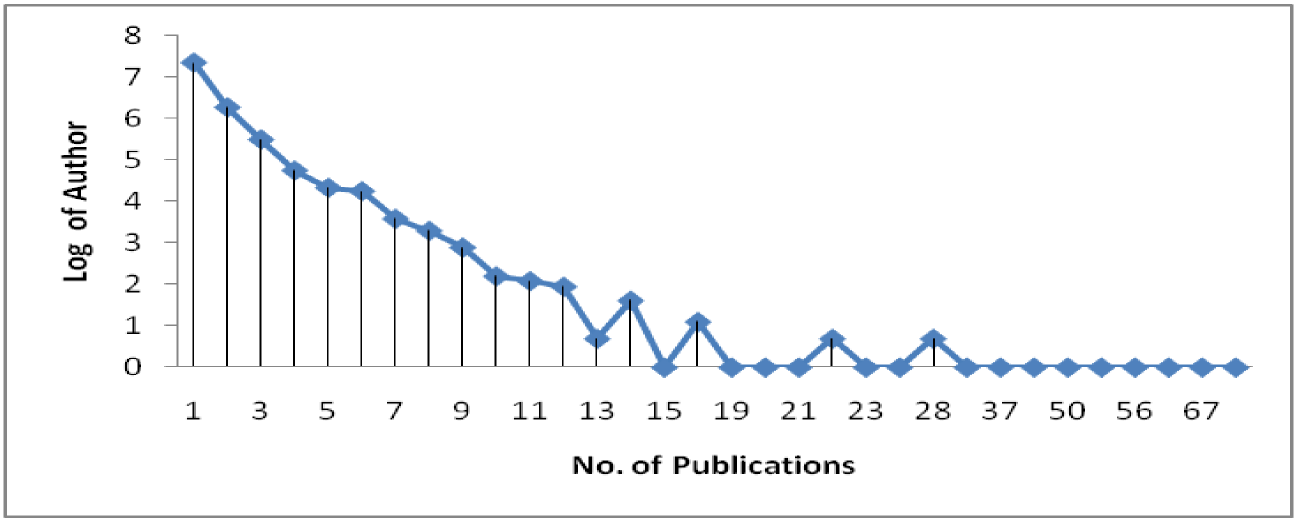
Chi –Square value has been tabulated using the exponent 'n'=2 for calculating the predicted Authors frequency distribution. It is observed that the calculated value of Chi-Suare=103.93 where as the theoretical critical value of chi-square at 0.05 level of significance is 46.19.

Comparing both of the values, it is found that the calculated value is greater than the critical value that rejects the applicability of Lotka's law for the given set of data.

Publication(*x*)	**Observed frequency of Authors (*Fi*)**	**Expected frequency of Author (*Pi*)**	***Fi* – *Pi***	**(*Fi* – *Pi*)^2**	**(*Fi* – *Pi*)^2 / *Pi***
1	1554	1653	-99	9801	5.929219601
2	527	413	114	12996	31.46731235
3	243	184	59	3481	18.91847826
4	115	103	12	144	1.398058252
5	76	66	10	100	1.515151515
6	70	46	24	576	12.52173913
7	36	34	2	4	0.117647059
8	27	26	1	1	0.038461538
9	18	20	-2	4	0.2
10	9	17	-8	64	3.764705882
11	8	14	-6	36	2.571428571
12	7	11	-4	16	1.454545455
13	2	10	-8	64	6.4
14	5	8	-3	9	1.125
15	1	7	-6	36	5.142857143
17	3	6	-3	9	1.5
19	1	5	-4	16	3.2
20	1	4	-3	9	2.25
21	1	4	-3	9	2.25
22	2	3	-1	1	0.333333333
23	1	3	-2	4	1.333333333
26	1	2	-1	1	0.5
28	2	2	0	0	0
35	1	1	0	0	0
37	1	1	0	0	0
38	1	1	0	0	0
50	1	1	0	0	0
52	1	1	0	0	0
56	1	1	0	0	0
58	1	0	0	0	0
67	1	0	0	0	0
110	1	0	0	0	0
	2719	2647	**Chi-Square (χ^2)**		**103.9312714**

Table: 05

8. **Graphical Presentation of Author's frequency distribution**



Graph: 01: Log of Author with number of Publications

The above shown graph no.01 reflect the graphical presentation of observed frequency distribution of publication productivity of authors in the given set of data. The graph does not support the applicability of Lotka's Law for the literature of Astronomy & Astrophysics research in India.

9. **Conclusion**

The statistical tests have been done with the data set shows that the Lotka's law in its generalized form does not fit the contribution frequency of authors' productivity. The inverse square form of productivity also not fitted with the data set in terms of author's productivity pattern distribution. Statistical methods determine the goodness of fit with a set of observed values and value which is predicted theoretically. K-S test as well as Chi-Square test has been applied to verify the applicability of the Lotka's Law on the data set but both of the goodness of fit tests have rejected the null hypothesis. It can be concluded from the studied data set that the Lotka's Law of scientific productivity doesn't fit to the literature of Astronomy & Astrophysics research of India.

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