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Analysis of Scholarly Communication on Quantum Cosmology at Global Perspective: A Scientometric Study

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ABSTRACT

The study examines Quantum Cosmology research as revealed by the scholarly publication indexed in the Web of Science database for the period ten years from 2011 to 2020. It was seen that the analyses included research growth publication, author productivity, major collaborative authors, global publications, keyword occurrence, and cited reference publications. The study reveals that the highest number of average authors per paper 3.06 in the year 2020, in productivity per author wise analysis preponderance of records was placed in the year 2011 were 0.45, the highest number of publication published Odintsov SD 33 articles with 1581 citation, and 22 h-index. The mean doubling time for the periods of 2010-2014 and 2015-2019 is 0.22 and 0.37 years respectively. The USA published 667 papers with 25.00 percentage, 241 local citation score, and 14410 global citation score. The Quantum keyword has the highest distribution in the field of Quantum Cosmology. The above-mentioned points are deeply analyzed.

Keywords: Authorship Productivity, Lotka's Law, Collaborative Authors, Quantum Cosmology, Scientometric and Web of Science.

INTRODUCTION

Scientometric is the quantitative study of science, it aims to analyze and evaluate science, technology, and innovation. The major research includes measuring the impact of authors, publications, journals, institutes, and countries as referenced to a set of scientific publications such as articles and patents. It also aims to understand the behavior of scientific citations as a means of scholarly communication and map the intellectual landscapes of science. Other effort focuses on the production of indicators for use in the evaluation of performance and productivity. The most important point to be discussed in the paper is how Scientometric studies develop the sources of the writer and their citation of the discussed papers irrespectively. By keeping this view in mind, the researchers wish to analyze the research involvement of the Quantum Cosmology research during 2011- 2020. Quantum Cosmology is the attempt in theoretical physics to develop a quantum theory of the universe. This approach attempts to answer open questions of classical physical cosmology particularly those related to the phases of the universe. The present study is entitled Analysis of Scholarly Communication on Quantum Cosmology at Global Perspective: A Scientometric Study. The present study is an attempt to Scientometric measures of the published research Performance of Quantum Cosmology to use various statistical tools.

REVIEW OF LITERATURE

Mohammad Ameen., Saddam Hosassin., and Sadik Batcha, M. (2020) the study focused on articles published in dentistry research within the period of 1999-2018. There is a total of 15970 records were found during the study period. The highest number of records published 1536 articles with 9.26 percentages in 2018 out of 19570. The four author's contribution the highest number of publications 10976 articles with 16.69 percentage and occupied the first rank. The author of Lang WP is on the top position published 89 articles with a 26 h-index score and the g-index score of 59.

Murugan, C., and Sringa, R. (2019) have examined the otorhinolaryngology research during 1989-2018; the required data were obtained from the Web of Science database with a total of 2039 publications. The maximum number of articles 199 (9.80%) were published in the year 2017. The mean relative growth rate for the period 1989-2018 was 10.57 and the average exponential growth rate was 35.61. The International Journal of Pediatric Otorhinolaryngology had contributed 147 (7.20%) a publication making it is the most preferred Journal.

Sathiya Priya, C. and Gomathi, P. (2019) have analyzed immunology research output during the year 1993-2017 (25 years) study based on the Web of Science database. It is identified that a total of 397 articles were published. The mean relative growth rates of 9.54, mean doubling time for publication at the aggregate level have been designed at 22.06. The maximum h-index score for highly productive authors is Saba, B 7 h-index. Immunology is a keyword that was used frequently in 46 articles with 287 percentage of the immunology research output.

Ranganathan. C. (2014) the study examines Oceanography research in India as revealed by the scholarly publication indexed in Aquatic Science and Fisheries Abstract (ASFA) database for the period 2008-2013 (fifteen years). The publication output has been analyzed with research growth, author productivity, authorship pattern, geographical distribution, major productive journals, etc. The study that most of the researchers preferred to publish their research results in journals as such 67.78 percentages of articles were published in journals, the highest numbers of articles were published in the year 2013. Lotka's law productivity distribution data partially fits the law when the value of Chi-square to 199.01.

Balasubramani, R. and Murugan, C. (2011) the study focused on articles published in Tapioca (Sago) research within the period of 1973-2010. There is a total of 447 records were found during the study period. The highest number of the publication produced 38 articles in 2008, the most productive journal in starch-starke 40 papers with 8.94% of overall published in this Tapioca (Saga) research output. The researchers' landscape has been established illustrating the major research cluster about the clustering concept. The highest paper published Moorthi SN 38 papers with 8.50 percentages.

OBJECTIVES OF THE STUDY

The major objectives are framed with the exclusive notion of the present study as mentioned below:

- To examine the year wise distribution of authorship productivity
- To measure the relative growth rate and double time in quantum cosmology
- To find out the h-index level of most prolific authors
- To find out the collaborative authors
- To determine the ranking of keywords wise distribution
- To identify the cited reference in quantum cosmology research

METHODOLOGY

The required data were collected from the Web of Science database maintained by Thomson Reuters for a period of ten years from 2011 to 2020. It can be seen that the total number of 2672 bibliographic records were retrieved from Quantum Cosmology research. The details with the observation that for each published article such as authorship productivity, Collaborative authors, keyword occurrence, ranking of country, etc., The Quantum Cosmology research bibliographic record was analyzed using the Bibexcel, Histcite, VOSviewer and MS Excel.

ANALYSIS AND RESULTS

Table 1: Year wise distribution of Authorship Productivity

S. No	Year of Publications	Records	Authors	AAPP	PPA
1	2011	214	477	2.23	0.45
2	2012	236	575	2.44	0.41
3	2013	228	550	2.41	0.41
4	2014	289	716	2.48	0.40
5	2015	267	621	2.33	0.43
6	2016	270	783	2.90	0.34
7	2017	286	733	2.56	0.39
8	2018	287	782	2.74	0.37
9	2019	287	745	2.60	0.39
10	2020	308	941	3.06	0.33
Total		2672	6923	2.59	0.39

**AAPP - Average Author Per Paper *PPA – Productivity Per Author*

Table 1 show the data related to average authors per paper and productivity per author in quantum cosmology research during 2011- 2020. The overall average author per paper 2.59 and the productivity per author are 0.39. The highest number of author's productivity 941 in the year 2020. The smallest number of author's productivity 214 in the year 2011, the highest number of average authors per paper 3.06 in the year 2020. In productivity per author wise analysis preponderance of records was placed in the year 2011 was 0.45. The lowest report was founded in the year 2020 was 0.33. The authorship productivity wise analysis growing level on the research period and the productivity per author's level is increasing level on the quantum cosmology research.

Table 2: Relative Growth Rate and Doubling Time of Publication

Year	Publication	Cumulative	W1	W2	R(a) (W2- W1)	Mean R(a)= W2- W1	Dt (0.693/R(a))	Mean Dt(a)
2011	214	214	-	5.37	-	0.89	-	0.22
2012	236	450	5.46	6.11	0.65		1.10	
2013	228	678	5.43	6.52	1.09		0.68	
2014	289	967	5.67	6.87	1.20		0.54	
2015	267	1234	5.59	7.12	1.53		0.56	
2016	270	1504	5.6	7.32	1.72	1.96	0.40	0.37
2017	286	1790	5.66	7.49	1.83		0.39	
2018	287	2077	5.66	7.64	1.98		0.36	
2019	287	2364	5.66	7.77	2.11		0.36	
2020	308	2672	5.73	7.89	2.16		0.33	
Total	2672					1.42		0.30

Table 2 indicates the relative growth rate and doubling time calculated for the publication of quantum cosmology research from the period from 2011 to 2020. The mean relative growth rate of publications comes increased from 0.65 in the year 2012 to 2.16 in the year 2020 for the ten years 2011 to 2020. The mean relative growth for the first five years 2011 to 2015 exhibits a growth of 0.89. Similarly for the next five years, 2016 to 2020 for the growth is 1.96. The overall research period has witnessed a mean relative growth rate of 1.42. The mean doubling time for the periods of 2010-2014 and 2015-2019 is 0.22 and 0.37 years respectively. The overall research period has witnessed a doubling time for astronomy publications in 0.30.

Table: 3 H-Index level of most Prolific Authors

Author	All articles	All citations	Citation sum within h-core	H-Index	Rank
Odintsov SD	33	1581	1447	22	1
Singh P	40	1427	1263	19	2
Bojowald M	40	910	761	16	3
Barrau A	28	859	775	16	4
Wang AZ	24	412	351	15	5
Oikonomou VK	26	651	573	15	6
Wilson-Ewing E	24	691	617	15	7
Calcagni G	17	663	646	14	8

Ashtekar A	17	1195	1177	13	9
Marugan GAM	34	596	454	13	10
Oriti D	17	583	540	13	11
Gielen S	18	494	463	13	12
Capozziello S	21	1888	1836	12	13
Grain J	14	596	587	12	14
Zhu T	16	284	267	12	15
Kamenshchik AY	22	486	444	12	16
Gupt B	14	404	389	12	17
Cai YF	11	721	721	11	18
Myrzakulov R	20	540	510	11	19
Martin-Benito M	18	357	311	10	20

Table 3 show that the h-index level of the most prolific author of quantum cosmology research. It was observed that there of 2672 bibliography records, it is the top 20 most productive authors citation and h-index during the period from 2011 to 2020. Odintsov SD published 33 articles, 1581 citation and 22 h-index, followed by Singh P published 40 articles, 1427 citation, and 19 h-index, Bojowald M published 40 articles, 910 citations, and 16 h-index, Barrau A published 28 articles, 859 citations, and 16 h-index, Wang AZ published 24 articles, 412 citations, and 15 h-index and Oikonomou VK published 26 articles, 651 citations, and 15 h-index. Other authors were h-index has 14 to 10 but citation and publications different values.

Table 4: Top 20 Collaborative Authors

S.No	Collaborative Authors		Records
1	Odintsov SD	Oikonomou VK	32
2	Marugan GAM	Navascues BE	30
3	Wang AZ	Zhu T	28
4	Martinbenito M	Marugan GAM	22
5	Nojiri S	Odintsov SD	20
6	Martinbenito M	Navascues BE	14
7	Marugan GAM	Olmedo J	14
8	Gielen S	Oriti D	12
9	Barvinsky AO	Kamenshchik AY	12
10	Bojowald M	Brahma S	12
11	Cianfrani F	Montani G	12
12	Deharo J	Odintsov SD	10

13	Myrzakulov R	Odintsov SD	10
14	Barrau A	Mielczarek J	10
15	Singh P	Wang AZ	10
16	Bojowald M	Calcagni G	8
17	Myrzakulov R	Nojiri S	6
18	Nojiri S	Oikonomou VK	6
19	Oriti D	Wilsonewing E	6
20	Calcagni G	Gielen S	4

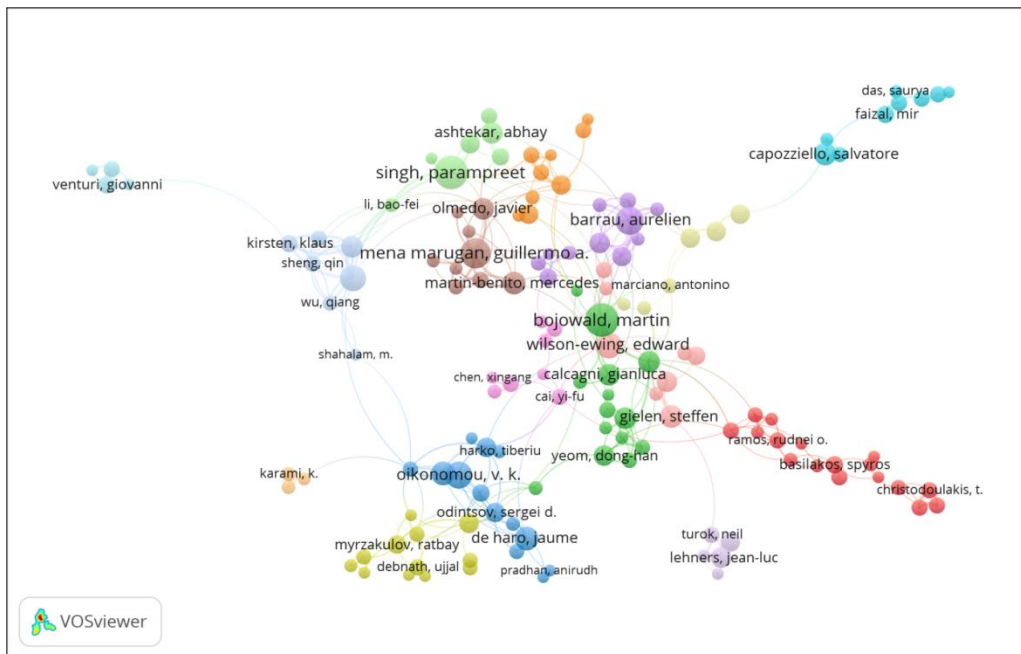


Figure 1: Network visualization of collaborative authors

Table 4 and figure 1 shows the top twenty collaborative authors for the publication of quantum cosmology research in the period from 2011 to 2020. Odintsov SD and Oikonomou VK jointly produced 32 articles, Marugan GAM and Navascues BE jointly produced 30 articles. Wang AZ. and Zhu T jointly produced 28 articles. Martinbenito M and Martinbenito M jointly produced 22 articles. Nojiri S and Odintsov SD jointly produced 20 articles and other author's collaborations are considerably less than 20 articles.

Table 5: Lotka's Law of Scientific Author Productivity

X	Y	ΣX = ln X	ΣX = ln Y	ΣX*Y	ΣX*X
1	662	0	6.495266	0	0
2	1686	0.693147181	7.430114	5.150163	0.480453
3	2082	1.098612289	7.641084	8.394589	1.206949
4	1180	1.386294361	7.07327	9.805634	1.921812
5	550	1.609437912	6.309918	10.15542	2.59029
6	186	1.791759469	5.225747	9.363281	3.210402
7	49	1.945910149	3.89182	7.573133	3.786566
8	40	2.079441542	3.688879	7.670809	4.324077
9	54	2.197224577	3.988984	8.764694	4.827796
10	20	2.302585093	2.995732	6.897928	5.301898
11	44	2.397895273	3.78419	9.07409	5.749902
12	48	2.48490665	3.871201	9.619573	6.174761
14	28	2.63905733	3.332205	8.793879	6.964624
15	15	2.708050201	2.70805	7.333536	7.333536
17	17	2.833213344	2.833213	8.027098	8.027098
20	40	2.995732274	3.688879	11.0509	8.974412
27	27	3.295836866	3.295837	10.86254	10.86254
57	57	4.043051268	4.043051	16.34626	16.34626
138	138	4.927253685	4.927254	24.27783	24.27783
Total	6923	5.902633333	8.842604	52.19465	34.84108

Productivity of author in the field of Quantum Cosmology show that out of 6923 authors, the three output has given by 2082 authors. They have produced three articles. 1686 produced two articles, the distribution of authors' more than 17 articles is found to quite small. The testing of Lotka's law is determined the value of n

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

$$n = \frac{19(52.19465) - (5.902633333)(8.842604)}{19(34.84108) - (5.902633333)(5.902633333)}$$

$$n = \frac{939.5037}{627.1394}$$

$$n = 1.498078$$

Table 6: Ranking of Country wise distribution of publications

Rank	Keywords	Records	Percentage	TLCS	TGCS
1	USA	667	25.00	241	14410
2	Germany	299	11.19	184	6796
3	UK	262	9.81	105	5076
4	Italy	232	8.68	187	5525
5	Spain	227	8.5	142	5620
6	Peoples R China	214	8.00	105	2755
7	Canada	194	7.26	73	3860
8	France	187	7.00	92	4795
9	India	172	6.44	79	1641
10	Russia	168	6.29	106	3319
11	Japan	161	6.03	65	3603
12	Brazil	155	5.80	31	1654
13	Iran	128	4.79	69	1313
14	Poland	109	4.08	5	1296
15	Mexico	96	3.59	58	945
16	Netherlands	79	2.96	102	2090
17	Greece	76	2.84	39	1353
18	Switzerland	65	2.43	28	1746
19	Portugal	63	2.36	29	760
20	Chile	56	2.10	12	1149

**TLCS – Total Local Citation Score *TGCS – Total Global Citation Score*

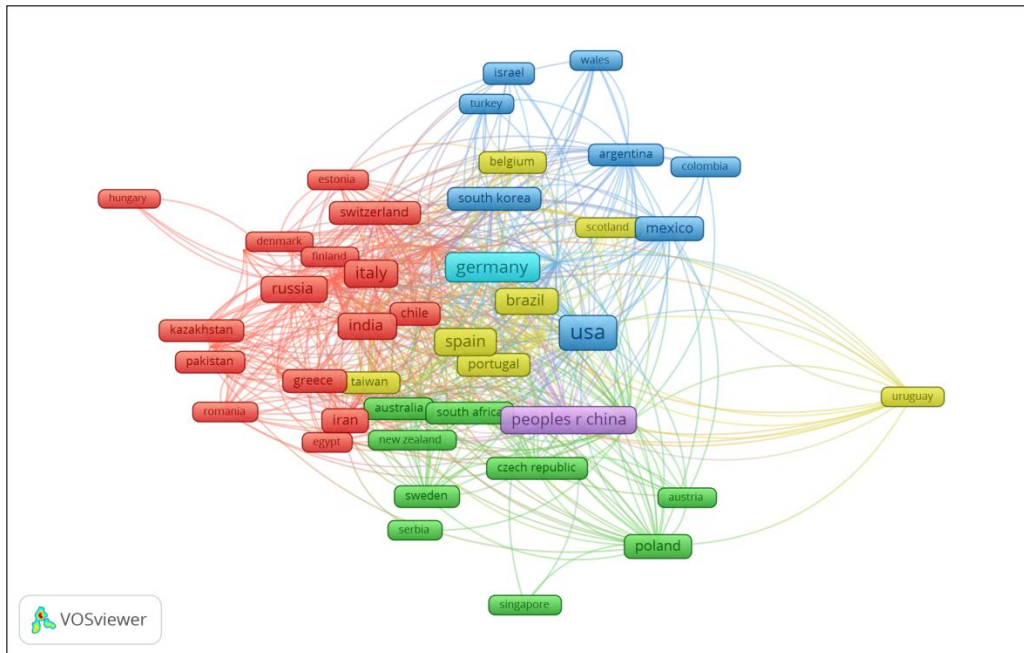


Figure 2: Network visualization of citation with countries

Table 6 and figure 2 show the ranking of countries wise papers with the top 20 countries during 2011-2020, in a total number of 83 countries that participated in Quantum Cosmology research. The USA published 667 papers with 25.00 percentage, 241 local citation score, and 14410 global citation score. followed by Germany published 299 paper with 11.19 percentage, 181 local citation score and 6796 global citation, the UK produced 262 papers with 9.81 percentage, 105 local citation score and 5096 of global citation and India published 172 paper with a 6.44 percentage, 79 local citation score and 1641 of global citation score which is occupied the ninth position in Quantum Cosmology research in the world.

Table 7: Keywords wise output of Quantum Cosmology

S. No	Keywords	Records	Percentage	TLCS	TGCS
1	Quantum	989	37.00	589	15105
2	Cosmology	795	29.80	453	11740
3	Gravity	426	15.90	358	9815
4	Loop	371	13.90	225	6877
5	Inflation	250	9.40	137	5148
6	Cosmological	238	8.90	159	3536
7	Universe	224	8.40	83	2638

global citation score, followed by Cosmology 795 (29.80%) research papers with 453 of local citation score and 11740 of global citation score, Gravity 426 (15.90%) research papers with 358 of local citation score and 9815 of global citation score and Loop 371 (13.90%) research papers with 225 of local citation score and 6877 of global citation score.

Table 8: Time Serious Analysis

Years	Number of Publication	X	X²	XY
2011	214	-4	16	-856
2012	236	-3	9	-708
2013	228	-2	4	-456
2014	289	-1	1	-289
2015	267	0	0	0
2016	270	1	1	270
2017	286	2	4	572
2018	287	3	9	861
2019	287	4	16	1148
2020	308	5	25	1540
Total	2672		85	2082

Straight line equation: $Y_t = a+bx$

$$a = \frac{\sum y}{n}$$

$$b = \frac{\sum xy}{\sum x^2}$$

$$a = \frac{2672}{10} = 267.2$$

$$b = \frac{2082}{85} = 24.49$$

Estimated literature in 2024 is when $X = 2024-2014 = 10$

$$= 267.2+24.49*10$$

$$= 267.2+244.9$$

$$= 512.1$$

Estimated literature in 2029 is when $X = 2029-2014 = 15$

$$= 267.2+24.49*15$$

$$= 267.2+367.35$$

$$= 634.55$$

The calculated value of time serious analysis of deforestation for the year 2024 is 512 and the research output for the year 2029 is 634.

Table 9: Top 20 Cited Reference in Quantum Cosmology Research

S. No	Author / Year / Journal	Records
1	Ade PAR, 2014, Astron Astrophys, V571, DOI 10.1051/0004-6361/201321554	396
2	Ashtekar A, 2011, Classical Quant Grav, V28, DOI 10.1088/0264-9381/28/21/213001	381
3	Ashtekar A, 2006, Phys Rev D, V74, DOI 10.1103/PhysRevD.74.084003	367
4	Guth AH, 1981, Phys Rev D, V23, P347, DOI 10.1103/PhysRevD.23.347	333
5	Starobinsky AA, 1980, Phys Lett B, V91, P99, DOI 10.1016/0370-2693(80)90670-X	302
6	Dewitt BS, 1967, Phys Rev, V160, P1113, DOI 10.1103/PhysRev.160.1113	273
7	Riess AG, 1998, Astron J, V116, P1009, DOI 10.1086/300499	267
8	Hartle JB, 1983, Phys Rev D, V28, P2960, DOI 10.1103/PhysRevD.28.2960	257
9	Perlmutter S, 1999, Astrophys J, V517, P565, DOI 10.1086/307221	257
10	Ade PAR, 2016, Astron Astrophys, V594, DOI 10.1051/0004-6361/201525830	252
11	Linde AD, 1982, Phys Lett B, V108, P389, DOI 10.1016/0370-2693(82)91219-9	244
12	Ashtekar A, 2003, Adv Theor Math Phys, V7, P233	206
13	Ashtekar A, 2004, Classical Quant Grav, V21, pR53, DOI 10.1088/0264-9381/21/15/R01	201
14	Ashtekar A, 2006, Phys Rev Lett, V96, DOI 10.1103/PhysRevLett.96.141301	197
15	Albrecht A, 1982, Phys Rev Lett, V48, P1220, DOI 10.1103/PhysRevLett.48.1220	195
16	Ashtekar A, 2009, Phys Rev D, V79, DOI 10.1103/PhysRevD.79.083535	190
17	Ashtekar A, 2008, Phys Rev D, V77, DOI 10.1103/PhysRevD.77.024046	187
18	Rovelli C., 2004, Quantum Gravity	185
19	Ashtekar A, 2006, Phys Rev D, V73, DOI 10.1103/PhysRevD.73.124038	183
20	Bojowald M, 2008, Living Rev Relativ, V11, DOI 10.12942/lrr-2008-4	180

Table 9 observed that the source, Ade PAR, 2014, *Astron Astrophys*, V571, DOI 10.1051/0004-6361/201321554 is the highest cited reference in the quantum cosmology with the frequency of 396 articles, followed by Ashtekar A, 2011, *Classical Quant Grav*, V28, DOI 10.1088/0264-9381/28/21/213001 is cited by 381 articles, Ashtekar A, 2006, *Phys Rev D*, V74, DOI 10.1103/PhysRevD.74.084003 is cited by 367 articles, Guth AH, 1981, *Phys Rev D*, V23, P347, DOI 10.1103/PhysRevD.23.347 is cited by 333 and Starobinsky AA, 1980, *Phys Lett B*, V91, P99, DOI 10.1016/0370-2693(80)90670-X is cited by 333.

FINDINGS AND CONCLUSION

The study quantitatively identified the research output in the field of Quantum Cosmology at the global level over the study period of 2011-2020. The study identified the mean doubling time for the periods of 2010-2014 and 2015-2019 is 0.22 and 0.37 years respectively. The overall research period has witnessed a doubling time for astronomy publications in 0.30. The time series analysis of deforestation for the year 2024 is 512 and the research output for the year 2029 is 634. A total number of 83 countries participated in Quantum Cosmology research, USA published 667 papers with 25.00 percentage, 241 local citation score, and 14410 global citation score which is occupied the first position in Quantum Cosmology research in the world. The keyword quantum has the highest distribution in the field of Quantum Cosmology, i.e. 989 (37.00%) research papers.

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