

## SCIENTOMETRIC PROFILE OF SPACECRAFT RESEARCH PUBLICATIONS



### Library Science

**KEYWORDS:** Spacecraft, Aerospace, Spaceship, Orbital vehicle, Rocket ship

**K.Sivasami**

Assistant Professor, Library and Information Science Wing, Directorate of Distance Education, Annamalai University, Annamalai Nagar – 608002, Tamilnadu, India

### ABSTRACT

This paper discuss on Scientometric profile of spacecraft research publications, present study has been analyzed and discusses on year wise publications, relative growth rate and doubling time during the study period, document types, Languages wise, and top ten institutions in spacecraft research. Moreover, Authorship pattern, top ten Source, top ten countries in this research, top ten author's contribution in Spacecraft research. Top ten Spacecraft published source's SNIP, SJR, h-index value and Impact Factor value. The study reveals that year wise analysis shown an increase the number of publications in spacecraft research. Totally 2303 institutions were contributing in this research during the study period, among the institutions "National Aeronautics and Space Administration (NASA)" has occupies first position with 327 papers, Totally 53 countries were contributing in this research among the those counties United States of America has contributing 35.56 percent of papers.

### INTRODUCTION

A spacecraft is a vehicle or machine designed to fly in outer space. Spacecraft are used for a variety of purposes, including communications, earth observation, meteorology, navigation, space colonization, planetary exploration, and transportation of humans and cargo (Reviews, CTI. 2016). Spacecraft used for human spaceflight carry people on board as crew or passengers from start or on orbit (space stations) only, while those used for robotic space missions operate either autonomously or telerobotically. Robotic spacecraft used to support scientific research are space probes. Robotic spacecraft that remain in orbit around a planetary body are artificial satellites (Spacecraft, New World Encyclopedia). The first manned spacecraft was Vostok 1, which carried Soviet cosmonaut Yuri Gagarin into space in 1961, and completed a full Earth orbit. There were five other manned missions which used a Vostok spacecraft (*Vostok*).

### METHODOLOGY

The data have been collected from Web of Science database, search string were used 'Spacecraft' in title search box, time span field have been select from 1991 to 2015. Totally 4647 records were retrieved, downloaded and analyzed as per objectives of the present study. Moreover, Journal Rank, Source Normalized Impact per Paper (SNIP), and SCImago Journal Rank (SJR) also has been used for Impact factor and h- index value.

### Relative Growth Rate (RGR)

The relative growth rate is the increase in the number of publications/ pages per unit of time. Here, one year is taken as the unit of time. The mean relative growth rate R (1-2) over a specified period of interval can be calculated from the following equation suggested by Mahapatra (1985).

$$R(1-2) = \frac{W2 - W1}{T2 - T1}$$

Where,

R = Mean relative growth rate over the specific period of interval;  
 W1 = log w1 (Natural log of initial number of publications/ pages);  
 W2 = log w2 (Natural log of initial number of publications/pages);  
 T2- T1 = Unit difference between the initial time and final time.  
 Therefore,  
 R (a) = Relative growth rate per unit of publications per unit of time (year)  
 R (p) = Relative growth rate per unit of pages per unit of time (year)

### Doubling Time (DT)

A direct equivalence exists between the relative growth rate and doubling time. If the number of publications/pages of a subject doubles during a given period, then the difference between the

logarithms of the numbers at the beginning and at the end of the period must be the logarithms of the number 2. This difference has a value of 0.693. Thus, the corresponding Doubling Time (DT) for publication and pages can be calculated by the following formula:

$$\text{Doubling Time (DT)} = \frac{0.693}{R}$$

Therefore,

$$\text{Doubling Time for Publications DT (a)} = \frac{0.693}{R(a)}$$

### OBJECTIVES

The following objectives of the present study are;

- To find growth of spacecraft publications during study period
- To find top ten institutions contributed in spacecraft research
- To find top ten author's contributions in spacecraft Research
- To find out top ten cited article in spacecraft research papers
- To find top ten spacecraft published source's h-index value

### ANALYSIS AND INTERPRETATIONS

**Table 1 year wise Spacecraft research Publications**

Sl. No	Years	No. of records	Percentages
1	1991	106	2.28
2	1992	98	2.11
3	1993	99	2.13
4	1994	134	2.88
5	1995	152	3.27
6	1996	137	2.95
7	1997	142	3.06
8	1998	130	2.80
9	1999	164	3.53
10	2000	165	3.55
11	2001	179	3.85
12	2002	146	3.14
13	2003	180	3.87
14	2004	176	3.79
15	2005	185	3.98
16	2006	191	4.11
17	2007	187	4.02
18	2008	191	4.11
19	2009	222	4.78
20	2010	196	4.22
21	2011	241	5.19
22	2012	261	5.62
23	2013	276	5.94
24	2014	310	6.67
25	2015	379	8.16
	Total	4647	100.00

Table 1 shows year wise research publication in Spacecraft research, totally 4647 records retrieved during the study period, in the year 2015 has occupies first place with 379 records in this research, followed by 2014 has second place with 310 records, 2013 has third place with 276 records. Moreover, it found that, last five year means of 2011 to 2016 Spacecraft research publications shown on increasing trend, from 1991 to 2010 research performance in Spacecraft research shows an increasing and degreasing trend.

**Relative growth rate and doubling time**

Relative growth rate and doubling time (table 2), during the study period publication's Doubling Time mean value is 6.36. In 1991, the Spacecraft research publication was 106; gradually the research publications were raised above three times from 1991 to 2015, 379 in the year 2015. The relative growth rate mean is 0.16. It could be deducted from the above discussion that in generally is a progressive increase in the number of publications of research publications on Spacecraft.

**Table 2 Relative Growth Rate and Doubling Time of spacecraft research publications**

Sl. No	Publication Years	No. of Records	Cumulative total	W1	W2	W2-W1 R (a)	Mean R (a)	Doubling Time	Mean Dt (a)
1	1991	106	106		4.66				
2	1992	98	204	4.66	5.31	0.65		1.07	
3	1993	99	303	5.31	5.71	0.4		1.73	
4	1994	134	437	5.71	6.07	0.36		1.93	
5	1995	152	589	6.07	6.37	0.3	0.42	2.31	1.76
6	1996	137	726	6.37	6.58	0.21		3.30	
7	1997	142	868	6.58	6.76	0.18		3.85	
8	1998	130	998	6.76	6.89	0.13		5.33	
9	1999	164	1162	6.89	7.05	0.16		4.33	
10	2000	165	1327	7.05	7.19	0.14	0.16	4.95	4.35
11	2001	179	1506	7.19	7.31	0.12		5.78	
12	2002	146	1652	7.31	7.4	0.09		7.70	
13	2003	180	1832	7.4	7.51	0.11		6.30	
14	2004	176	2008	7.51	7.6	0.09	0.1	7.70	7.03
15	2005	185	2193	7.6	7.69	0.09		7.70	
16	2006	191	2384	7.69	7.77	0.08		8.66	
17	2007	187	2571	7.77	7.85	0.08		8.66	
18	2008	191	2762	7.85	7.92	0.07		9.90	
19	2009	222	2984	7.92	8	0.08	0.07	8.66	9.49
20	2010	196	3180	8	8.06	0.06		11.55	
21	2011	241	3421	8.06	8.13	0.07		9.90	
22	2012	261	3682	8.13	8.21	0.08		8.66	
23	2013	276	3958	8.21	8.28	0.07		9.90	
24	2014	310	4268	8.28	8.35	0.07	0.07	9.90	9.21
25	2015	379	4647	8.35	8.44	0.09		7.70	
	Total	4647				Mean	0.16		6.36

**Table 3 Document type wise research Publications in Spacecraft**

Sl. No	Document Types	Records	Percentages
1	Article	3611	77.71
2	Proceedings Paper	640	13.77
3	Editorial Material	95	2.04
4	News Item	94	2.02
5	Review	80	1.72
6	Note	46	0.99
7	Meeting Abstract	24	0.52
8	Letter	22	0.47
9	Correction	21	0.45

10	Book Review	6	0.13
11	Correction Addition	3	0.06
12	Discussion	2	0.04
13	Reprint	1	0.02
14	Book Chapter	1	0.02
15	Biographical Item	1	0.02
	Total	4647	100.00

Table 3 indicates that, document type wise research publications in Spacecraft, fifteen document types has contributing in this research, among the fifteen documents articles has occupies first position with 77.71 percentages, Second has Proceedings Paper 13.77 percentages, third place has Editorial Material has 3.04 percentages, followed by News Item has 2.02 percentages, Review has 1.72 percentages, Note has 0.99 percentages, Meeting Abstract 0.52 percentages, Letter has 0.47 percentages, Correction has 0.45 percentages, Book Review has 0.13 percentages, Correction Addition has 0.06 percentages, Discussion has 0.04 percentages, Reprint, Book Chapter, and Biographical Item has 0.02 percentages respectively.

**Table 4 Languages wise research publications**

Sl. No	Languages	Records	Percentages
1	English	4617	99.35
2	Russian	14	0.30
3	Chinese	9	0.19
4	German	3	0.07
5	French	2	0.04
6	Japanese	1	0.02
7	Italian	1	0.02
	Total	4647	100.00

Table 4 indicates that languages wise research publications in spacecraft research, among the 4647 papers, 99.35 percentages of paper published in English language, Russian language has second place with 0.30 percentages, Chinese has third place with 0.19 percentages, followed by French has 0.04 percentages, and Japanese and Italian has 0.02 percentages respectively.

**Table 5 Country wise research publications in Spacecraft**

Sl. No.	Countries/Territories	No. of records	% of 4647
1	United States of America	1654	35.59
2	Peoples R China	690	14.85
3	Russia	523	11.25
4	England	286	6.15
5	Germany	278	5.98
6	Japan	271	5.83
7	France	268	5.77
8	Italy	166	3.57
9	Netherlands	164	3.53
10	Canada	153	3.29
	43 countries	194	4.17
		4647	100.00

Table 5 shows that country wise research publications in Spacecraft, totally 53 countries contributing in this research among the those counties United States of America has contributing 35.56 percent of papers, Peoples Republic China has 14.85 percent of papers, Russia has third place with 11.25 percent of papers, England has contributing 6.15 percent of papers, Germany has 5.98 percentages, Japan has 5.83 percentages, France has 5.77 percentages, Italy has 3.57 percent, Netherlands has 3.53 percent with ninth place, Canada has tenth place with 3.29 percent of papers contributing in this research, the remaining 43 countries are contributing 4.17 percent of papers in this research.

**Table 6 top ten Institutions wise research publications**

Sl. No	Institutions	No. of records	% of 4647
1	National Aeronautics and Space Administration (NASA)	327	7.04
2	Caltech	254	5.47
3	Harbin Institute of Technology	207	4.45
4	Russian Academy of Sciences	181	3.89
5	Johns Hopkins University	116	2.50
6	European Space Agcy	89	1.92
7	University of Colorado	84	1.81
8	University of California Los Angeles	77	1.66
9	University California Berkeley	77	1.66
10	University of Michigan	76	1.64
	2293 Institutions	3159	67.98
	Total	4647	100.00

Table 6 indicated that top ten institutions research publications in Spacecraft research, totally 2303 institutions were contributing in this research during the study period, among the 2303 institutions, only top ten institutions are listed table 6. Among the institutions "National Aeronautics and Space Administration (NASA)" has occupies first position with 327 papers, "Caltech" has second place with 254 papers, "Harbin Institute of Technology" has third place with 207 records, "Russian Academy of Sciences" has fourth place with 181 papers, "Johns Hopkins University" has fifth place with 116 papers, "European Space Agcy" has sixth place with 89 papers, "University of Colorado" has seventh place with 84 papers, "University of California Los Angeles" and "University California Berkeley" has Eight and ninth place respectively with 77 papers, "University of Michigan" has occupies tenth place with 76 papers, moreover 2293 Institutions contributing 3159 papers in this research during the study period.

**Table 7 top ten author's contribution in Spacecraft research during 1991–2015**

Sl. No	Authors	Records	% of 4647
1	Hu Q L	77	1.65
2	Reme H	34	0.73
3	Venkateswaran K	30	0.64
4	Santolik O	30	0.64
5	Mukai T	27	0.58
6	Xiao B	26	0.56
7	Russell CT	26	0.56
8	Xu SJ	25	0.53
9	Frank LA	25	0.53
10	Torkar K	24	0.51
	9844 Authors		

Table 7 shows that, top ten authors are contributing in Spacecraft research during 1991 – 2015, totally 9854 authors were contributing in this research. Among the authors, Hu Q L has contributing 1.65 percent of papers in this research his contributing who occupies first position. Reme H has contributing second position with 0.73 percent of papers, Venkateswaran K and Santolik O each has contributing third and fourth places, followed by Mukai T has 0.58 percent of papers, Xiao B and Russell CT each authors were contributed 0.56 percent of papers, Xu SJ and Frank LA each author were occupies with eight and ninth place, Torkar K authors tenth position with 0.51 percent papers, the remaining 9844 authors were contributing 24 and less then contribution in this research.

**Table 8 Authorship pattern in Spacecraft research publications**

Sl. No.	No. of Authors	No. of Papers	Percentages
1	Single	905	19.47
2	Double	1197	25.76
3	Three	909	19.56
4	Four	627	13.49
5	Five	263	5.66
6	Six and Above	766	16.48
	Total	4647	100.00

Table 8 shows that Authorship pattern in Spacecraft research publications during 1991 to 2015, among the 4647 papers single author contributing are 19.47 percentages, followed by Double authors were contributed 25.76 percent of authors, Three authors were contributed 19.56 percent of papers, Four authors were contributing 13.49 percent of papers, five authors wear contributing 5.66 percent, and remaining 16.48 papers were contributed 16.48 percent of papers. Could be noted, single authors were contributing 17.47 percent only the remaining 80.95 percent of papers are collaborative author papers.

**Table 9 top ten Sources published in Spacecraft research**

Sl. No	Source Titles	No. of Records	% of 4647
1	Journal of Guidance, Control, and Dynamics	384	8.26
2	Acta Astronautica	295	6.35
3	Journal of Spacecraft and Rockets	276	5.94
4	Journal of Geophysical Research: Space Physics	224	4.82
5	Advances in Space Research	143	3.08
6	Cosmic Research	140	3.01
7	Journal of The Astronautical Sciences	86	1.85
8	Aerospace Science and Technology	77	1.66
9	IEEE Transactions on Plasma Science	73	1.57
10	Geophysical Research Letters	71	1.53
	701 Source	2878	61.93

Table 9 shows that top ten sources published in Spacecraft research papers, totally 2888 sources were published 4647 Spacecraft research papers, among the sources "Journal of Guidance Control and Dynamics" has published 384 papers with first position, "Acta Astronautica" has 295 papers with second place, "Journal of Spacecraft and Rocket" have published 276 papers with third place, "Journal of Geophysical Research Space Physics" has fourth place with 224 papers, "Advances in Space Research" has fifth place with 143 papers, "Cosmic Research" has sixth place with 140 papers, "Journal of The Astronautical Science" has seventh place with 86 papers, "Aerospace Science and Technology" has eight place with 77 papers, "IEEE Transactions on Plasma Science" has ninth place with 73 papers, "Geophysical Research Letters" has tenth place with 71 papers in Spacecraft research. Moreover, the remaining 701 sources were published 2878 papers in this research.

**Table 10 top ten Spacecraft published source's Impact factor and h-index value**

Sl. No.	Source title	No. of outputs in	SNIP	SJR	Impact Factor	h-index
1	Journal of Guidance, Control, and Dynamics	384	2.280	1.556	2.18	98
2	Acta Astronautica	295	1.237	0.726	1.09	43
3	Journal of Spacecraft and Rockets	276	1.283	0.74	0.93	55

4	Journal of Geophysical Research: Space	224	1.280	2.31	5.6	263
5	Advances in Space Research	143	1.071	0.606	1.4	65
6	Cosmic Research	140	0.650	0.328	0.61	14
7	Journal of the Astronautical Sciences	86	0.591	0.189	0.469	35
8	Aerospace Science and Technology	77	1.679	0.816	2.35	49
9	IEEE Transactions on Plasma Science	73	1.233	0.537	1.01	83
10	Geophysical Research Letters	71	1.407	3.323	4.212	185

Table 10 shows that top ten Spacecraft published source's SNIP, SJR, h-index value and Impact Factor value, Among the top ten sources "Journal of Geophysical Research: Space Physics" has Impact factor value is 5.6 and h-index value are 263, the remaining sources Impact Factor value are less than 5. Moreover, Geophysical Research Letters' h index value is 185, the remaining eight sources h index value are less than 100. Among the ten sources "Journal of Guidance, Control, and Dynamics" has Source Normalized Impact per Paper (SNIP) value is 2.280, the remaining nine sources' SNIP value are less than 2. Among the top ten sources' SCImago Journal Rank (SJR) value "Geophysical Research Letters" has 3.323, moreover remaining nine sources SJR value are less than 3.

## CONCLUSION

Conclude from this study, year wise research publications starting with 106 papers and it rose to 379 by the end of 2015, indicating more than three times of increase from 1991 to 2015. It found that, last five year means of 2011 to 2016 Spacecraft research publications shown on increasing trend, from 1991 to 2010 research performance in Spacecraft research shows an increasing and degreasing trend. Fifteen document types has contributing in this research articles has occupies first position with 77.71 percentages, 99.35 percentages of paper published in English language, United States of America has contributing 35.56 percent of papers, Peoples Republic China has 14.85 percent of papers, Russia has third place, among the 9854 authors Hu Q L has contributing 1.65 percent of papers in this research, 80.95 percent of papers were contributed Multi author papers. Journal of Geophysical Research: Space Physics" has Impact factor value is 5.6 and h-index value are 263, the remaining sources Impact Factor value are less than 5.

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