

# Analysis of Papers Published in the Journal of Astronomy and Space Sciences from 1984 to 2018

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This paper presents at the characteristics of publications in the *Journal of Astronomy and Space Sciences* from 1984 to 2018. Since its first publication, a total of 1,113 papers (~35 volumes) have been published up to December 2018. While the space astronomy field has made up a large portion of the total number of papers, the number of annually published papers in this field is decreasing. In contrast, the number of papers in the space environment field has been showing an increasing trend since 2013, accounting for more than 30% of the annual publications. The participation rate of foreign researchers has been maintained at greater than 20% since 2012. Despite the decrease in the number of paper per year, there are positive developments including sustained foreign researcher participation at greater than 20% and improvements in the impact factor. We believe that JASS has the potential to enter the distinguished level of international academic journals following a well-developed future road map.

**Keywords:** JASS (Journal of Astronomy and Space Sciences), analysis, historical astronomy

## 1. INTRODUCTION

The Korean Space Science Society (hereinafter referred to as KSSS) was founded on May 19, 1984. From September 30, 1984, the *Journal of Astronomy and Space Sciences* (hereafter referred to as JASS) Vol. 1 began publication. The *Bulletin of the Korean Space Science Society* was launched on October 2, 1992, and academic activities started from this time. On December 26, 1995, KSSS was granted permission to be considered an incorporated association by the Ministry of Science and Technology (currently the Ministry of Science and ICT) and was established as an official academic institution.

Once KSSS became an official academic institution, JASS, its academic journal, became a candidate for indexing in the Korea Citation Index (hereafter referred to as KCI), provided by the National Research Foundation of Korea in January 1999. Two years later, on December 19, 2001, JASS

was selected as an indexed academic journal in KCI. KSSS has firmly consolidated its position as an academic society by making agreements with similar societies in academic fields since JASS became a KCI journal. On May 12, 2006, KSSS concluded an agreement with the International Earth Science Olympiad (IESO), and on April 24, 2008, it entered into an agreement with the Korean Astronomical Society and the Korea Astronomy and Space Science Institute to cooperate for a joint project for the International Year of Astronomy. On April 28, 2009, the joint conference of the International Year of Astronomy was held, and on April 29, 2010, KSSS was approved to join the Korea Geosciences Union. As such, various KSSS activities also have had an effect in promoting JASS.

On June 9, 2010, JASS was assigned an ISSN (2093-5587). The title of the journal was also changed to the *Journal of Astronomy and Space Sciences (J. Astron. Space Sci.)*. In the meantime, the official language rules of the journal, which

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had allowed both Korean and English, were revised to only English based on rule changes in 2010. The purpose of this change was the internationalization of JASS. On November 23, 2011, JASS was selected as a SCOPUS-indexed journal; this achievement came 10 years after JASS became a KCI-indexed journal. Since then, KSSS has begun to distinguish itself as an international academic society, while carrying out various activities both domestically and internationally. For example, led by KSSS (2012) a collection of academic papers to commemorate Robert H. Koch (1929–2010), an American astronomer who had actively worked internationally through various research exchanges with domestic researchers on binary stars, was published in 2013. On July 13, 2013, KSSS concluded an agreement with the Korean Astronomical Society and the Korea Astronomy and Space Science Institute for the 12th General Assembly of the Asia-Pacific Region of the International Astronomical Union and the Korea Astronomy and Space Science Association on November 25, 2014. Then, on March 11, 2015, it co-organized a seminar celebrating the proclamation of the International Year of Light. As such, the activities of KSSS have contributed to JASS becoming known as an international journal, and the journal was indexed to ESCI (Emerging Sources Citation Index) in 2017. The promotion of JASS to ESCI was an outstanding achievement made six years after its indexing in SCOPUS.

As of December 31, 2018, KSSS has 1502 registered members; 621 full members and 16 honorary members. Currently (2019), Volume 36, Issues 1 and 2 of the academic journal have been published. KSSS is trying to upgrade JASS to the level of SCI(E) (Science Citation Index (Expanded)). Among the domestic academic journals in the field of space science and astronomy, the *Journal of the Korean Astronomical Society* (JKAS), *Journal of the Korean Society of Aeronautical and Space Science* (KSAS), and *International Journal of Aeronautical and Space Sciences* (IJAS) are available. Reviewing the impact factor (hereafter referred to as IF, two years) of these journals, as of 2017, the IF of JKAS is 0.24, KSAS is 0.25, and IJAS is 0.21 (NRF 2019). In particular, JKAS and KSAS are published six and 12 times every year, respectively, and are selected as journals in SCI(E). Compared to these, JASS is published only four times annually, but the IF is 0.48, which is approximately twice as high as the others. This indicates that JASS has raised its public profile in the worldwide academic society as an international journal.

JASS was first mentioned in 2001, in an article regarding the KSSS in the monthly magazine “Science and Technology” by Jeong Janghae, who was professor at Chungbuk National University. At that time, he argued

that much investment was needed in basic space science research, including the areas of rocket and satellite operation and automatic navigation systems, with a focus on cultivating future talent (Jeong 2001). Eighteen years later, satellites and automatic navigation systems are actively used in many fields in our society today. The argument of Jeong (2011) turned out to be meaningful. Later, in 2009, JASS was analyzed in an article on medium and long-term development plans for the Korea Space Science Association. For this, a total of 687 papers (1984–2008) were collected and analyzed (KSSS 2009). It is a meaningful analysis, considering that development plans were sought through the analysis of papers accumulated over 25 years.

It has been 36 years since KSSS was founded and JASS was first issued. Given the fact that academic journals will be continuously published, it is important to analyze the active characteristics of published journals (Choi & Hwang 2004) to comprehend the trends in research over time; an analysis of the papers published in JASS can provide an understanding of the development of modern astronomy. Among other things, the research is especially significant in that it can help to set larger goals for the development of society (Park 1996). We collected and analyzed papers published until 2018 (Volume 35, Issue 4). The collected papers were divided into various categories, such as era, author, affiliation, and theme, and then analyzed. In addition, we analyzed various research patterns, looking into the characteristics of quantitative changes and the changes in the research themes in detail. Finally, we put forward suggestions for the future research directions of JASS from the results generated by the analysis of the published papers.

The composition order of this paper is as follows. Section 2 briefly introduces the research method, and Section 3 explains the results of the research. Section 4 suggests future directions of JASS development, along with providing a conclusion.

## 2. METHODS

### 2.1 Data Collection

In this study, papers published up to Volume 35, Issue 4 issued in 2018, were collected and analyzed. JASS publications can be categorized into several types of research, such as technology, reviews, editorials, and special issues. However, for this study, all the papers were collected under a single perspective and not categorized further. A total of 1,113 papers was published over 35 years from 1984 to 2018.

These papers can be viewed on the JASS journal web server (<http://janss.kr>), which is publicly available (open access); thus, anyone can access the papers.

## 2.2 Research Method

This study was conducted through the research procedure and method of Cho & Kim (2014). The first step is to quantitatively examine the number of publications, issues, and papers published. In this process, additional classification was made according to the themes of the papers. Table 1 shows the research topics and details set for the classification of published papers. There were six categories altogether: space environment, space exploration, space application, space technology, space astronomy, and others. This type of classification corresponds to the session classification of academic conferences held by KSSS twice a year.

The space environment field was classified into the study of the sun, magnetosphere, ionosphere, upper atmosphere, and spacecraft. Space exploration was categorized into solar system research except the Earth and Sun, astronomical observations including asteroids and comets, and lunar exploration. Space application was categorized into the fields of geodesic research, payload, microgravity, and remote exploration. Space technology was classified into the research fields of satellite operation and development, including projectiles. Space astronomy was classified into the studies of observation instruments, general astronomy, and historical astronomy (or history of astronomy). Here, general astronomy refers to modern astronomical studies, including stellar evolution, astrophysics, and radio astronomy. Research papers that do not belong to any of the above categories were classified as others, and among them, studies on education and climate, including weather, were mainly identified.

As shown in Table 1, additional items were classified and organized to understand the overall volume change of the published papers and the rate of change according to research topic. To analyze the authors who published papers and their affiliations, authors were classified as lead authors and co-authors. Here, the lead authors were first authors

or corresponding authors. Other authors were classified as co-authors. We also collected keywords from the titles and abstracts of the papers to examine the changes and features of the published articles. The titles of papers were examined from those published between 1984 and 2018, and abstract keywords were collected and analyzed from the data after 2000. The study was based on basic statistical analysis, and we proposed future directions through these analysis results.

## 3. RESULTS

### 3.1 Change in the Number of Papers Published

JASS published 35 volumes over 35 years from 1984 to 2018, containing 1,113 papers. The historical JASS Volume 1 Issue 1 began in 1984. A total of six papers was published in Volume 1, with the first paper authored by Kyong Chol Chou (1929–2010), a professor at Kyung Hee University at the time (see Fig. 1). The title of the paper was “Aerodynamic Problems of Launch Vehicles,” and it dealt with dynamic problems associated with projectiles (Chou 1984). This paper was the beginning of JASS.

Only one issue was published for Volume 1 in 1984. In 1985, the Volume 2 contained two issues in a year, with Issue 1 and Issue 2 being published in June and December, respectively. This semi-annual publishing system continued until 2000. In 2001, Volume 18 was published three times a year, with Issue 1 in June, Issue 2 in November, and Issue 3 in December (KSSS 2009). However, 2001 began a period of sharp decline in the number of papers published after years of increase, and there was no need to publish three times that year (see Fig. 2). In addition, the publication of Issue 2 and Issue 3 had an interval of one month, which resulted in a very tight schedule. Such publication is thought to be related to the selection of JASS as an indexed journal in KCI in December 2001. After its selection as a KCI indexed journal, it was published four times a year, starting with Volume 19 in 2002. The quarterly publishing system, with Issue 1 in March, Issue 2 in June, Issue 3 in September, and Issue 4 in December, has continued to date (~2019).

**Table 1.** Subjects and details of research for classification of articles

	Subjects	Contents
1	Space environment	Sun (or solar), magnetosphere, ionosphere, space-ray
2	Space exploration	Solar system (except earth and sun), lunar exploration, space survey (including asteroids and comets)
3	Space application	Space geodesy, payload, application (including microgravity and remote sensing)
4	Space technology	Satellite operation, satellites (including space shuttles and rockets)
5	Space astronomy	Observation instruments, general astronomy, historical astronomy
6	Other	Education, meteorological (or climate)

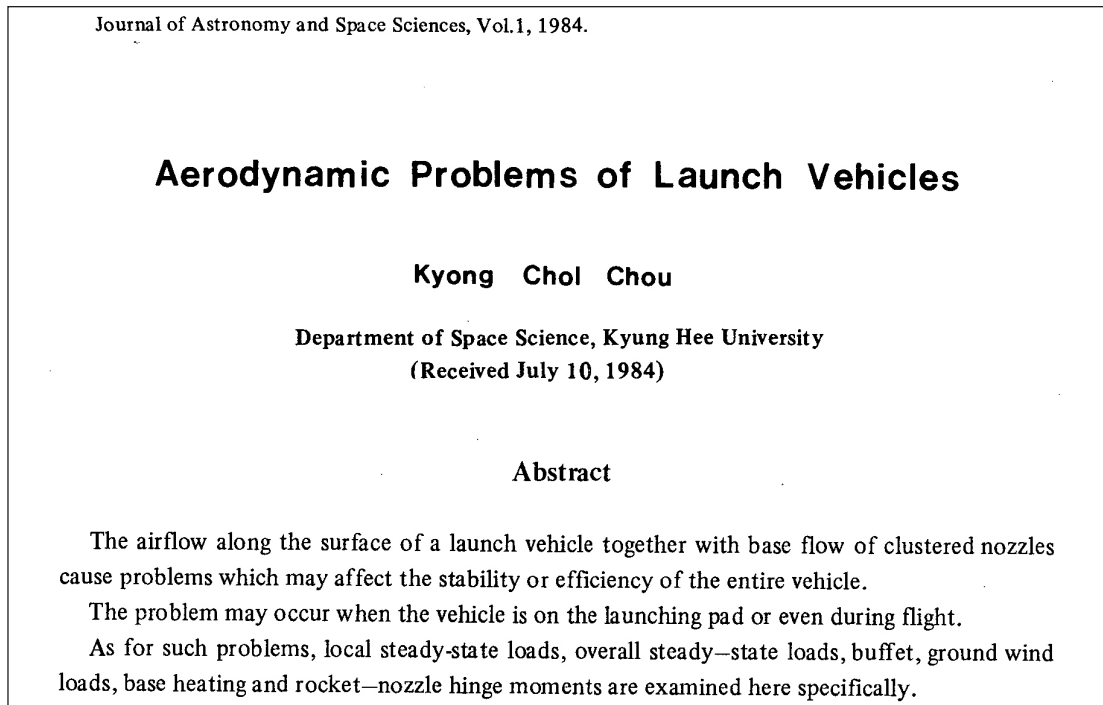


Fig. 1. Journal of Astronomy and Space Sciences, Vol. 1, 1984, 5-21.

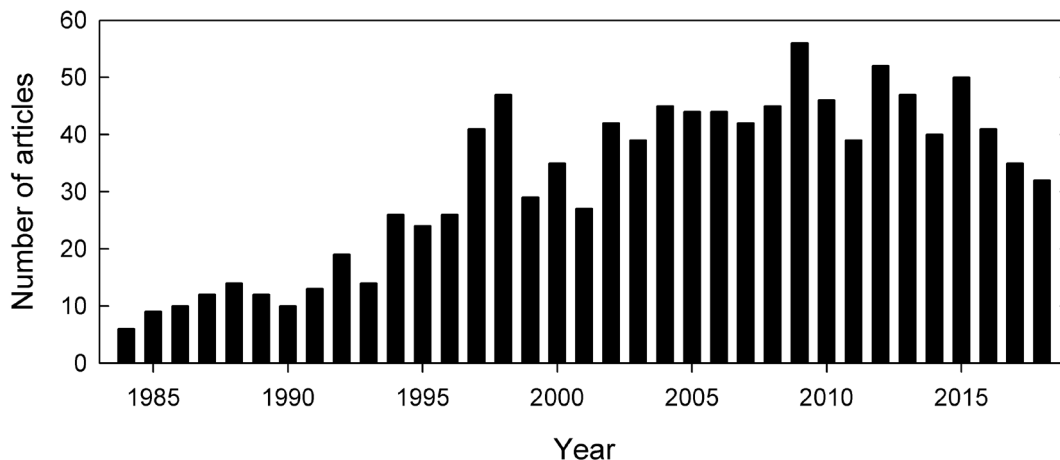
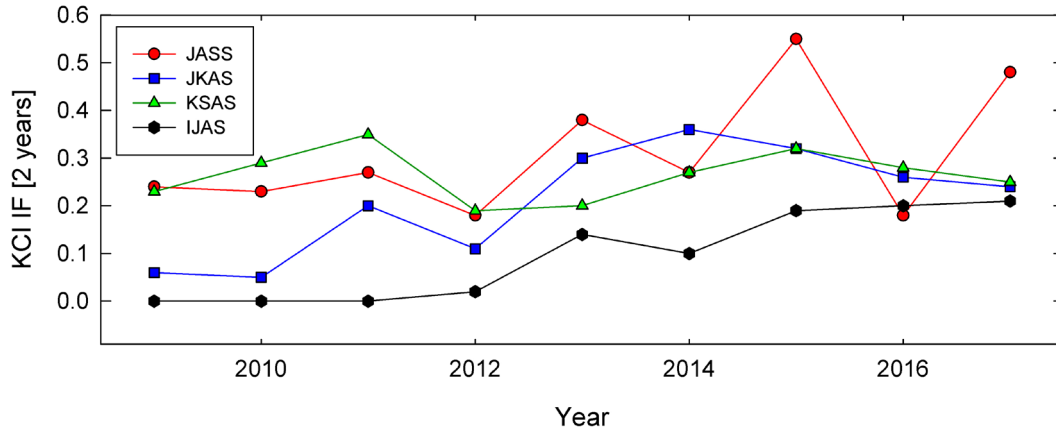


Fig. 2. Yearly distribution of number of papers published in JASS.

Fig. 2 shows a histogram of the number of papers published per year. Starting in 1984, six papers were published in Volume 1, Issue 1, increasing to 24 papers in 1994, a 4-fold increase over the span of 10 years. The number of papers continued to increase, reaching a total of 47 papers, double the number four years earlier, in 1998. The number of papers dropped to 27 in 2001, the year that the journal was selected as a KCI indexed journal, but began to increase with 42 papers published in 2002 (KSSS 2009). Afterwards, the number of papers published continued to increase, peaking in 2009 with 56 papers. However, since

then, the number of published papers has shown an overall gradual declining trend, following a slight degree of increase or decrease each year. This trend of decrease has continued until today, with the number of papers published in the most recent year of 2018 equaling 32, the lowest since 2002.

Fig. 3 shows the change in the impact factors during the period from 2009 to 2017 in JASS, JKAS, KSAS, and IJAS. The two-year average value of IF, which indicates the level and influence of academic journals, gradually increased from 0.18 in 2012 to 0.28 in 2013, 0.27 in 2014, and 0.55 in 2015 after registration with SCOPUS in 2011. It rapidly dropped



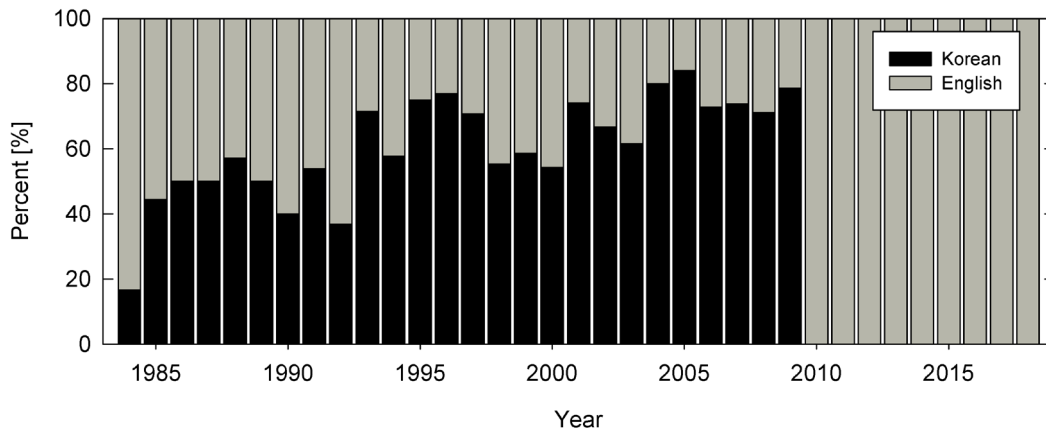
**Fig. 3.** Variation in impact factor from 2009 to 2017. JASS, Journal of Astronomy and Space Sciences; JKAS, Journal of the Korean Astronomical Society; KSAS, Journal of the Korean Society of Aeronautical and Space Science; IJAS, International Journal of Aeronautical and Space Sciences.

to 0.18 in 2016 but soared to 0.48 in 2017 (NRF 2019). The number of papers published every year in 2009 was on a declining trend, but the IF shows an increasing trend. There is concern regarding the reduction in quantity (Fig. 2); however, the improvement in the impact of the journal is meaningful. However, considering that the self-citation ratio of lead authors published in JASS from 2012 to 2017 is 78.3% on average and the impact factor fluctuation is much larger than that exhibited in other journals, specific analysis is needed, as the IF is difficult to predict. In this regard, JASS management staff will have to find various measures to increase the IF, even with the decreasing trend in the number of papers.

Fig. 4 presents the change in the language used by period in the publication of JASS over the years. Black indicates the use of the Korean language, while gray shows that of the English language. In the early years of the journal, a mix of Korean and English was used. Nevertheless, the percentage

of English use was higher, and after the mid-1990s, the use of Korean increased. After 2010, the journal placed a limit on the use of Korean and changed its rules to accept English-only submissions. The change was made in an effort to register JASS as an international academic journal.

The increasing trend in the number of papers published in total over the year has corresponded to the period in which the portion of Korean use has increased. We can see this trend in the late 1980s, mid-1990s, and mid-2000s. In contrast, the number of articles published tends to decline in the period when the proportion of Korean use decreases, and this tendency can be seen from the late 1990s to the early 2000s. JASS is an international journal currently indexed to ESCI; however, as KSSS is located in Korea, it is better known in Korea than abroad. The fact that the journal is published in English makes it difficult for domestic readers to access it. Because it is an international journal devoted to expertise in a certain field, writing articles in



**Fig. 4.** Variation in the proportion of languages used in JASS

English is required; however, it is certain that domestic readers who may have an interest and curiosity but are not academic experts are discouraged from accessing it. In this regard, for its long-term growth, it is necessary for JASS to seek ways to establish a wide domestic readership while maintaining its status firmly as an international journal. Therefore, it is necessary to find an effective way to address this issue.

### 3.2 Classification by Research Topic of Published Papers

A total of 1,113 papers collected was classified according to the research topics listed in Table 1. Table 2 further categorizes, summarizes, and organizes the research subjects, based on the details. In the space environment field, a total of 231 papers was identified, accounting for 20.8% of the total. In space environment, it was identified that research on the magnetosphere and ionosphere occupied more than half of the area, showing their dominant proportion. A total of 65 papers was in the field of space exploration, accounting for 5.8% of the total. The number of papers related to lunar exploration has increased over the past five years, and lunar exploration research has grown to exert a large influence on the proportion of total papers. This started with the preparation of the space exploration program in the first space development promotion basic plan (June 2007) and continued to the specifics of the lunar exploration plan in the detailed roadmap of the first space development promotion (November 2007). Each year since the planning research was conducted, research on lunar

exploration has been carried out with the establishment of the lunar exploration plan in 2008 (Choi et al. 2014). The number of papers in the space applications field is 117, accounting for 10.5% of the total. In the field of space applications, geodesy research shows a dominating proportion, comprising nearly half of the publications in this field. The space technology field accounts for 21.1% in total, with 235 papers. Research on satellite operation dominates the space technology field, accounting for more than 80% of the publications. The number of papers in space astronomy is identified as 448 accounting for 40.3% of the total. It is found that this field has the greatest weight in the total number of papers published over 35 years and has a great influence on the increase and decrease in the total number of papers of the journal. In the field of space astronomy, research papers on general astronomy are the most common. The detailed areas that constitute general astronomy are all included in the modern astronomy categories. Therefore, papers on modern astronomy account for a significant proportion of papers published in JASS and affect the total number of papers in the journal. In the others field, the total number of papers is 17 (The number of education-related papers and weather-related papers are identified as 2 and 15, respectively), 1.5%.

Fig. 5 shows the change in the distribution of papers by year according to research subject. In the early stages of JASS publication, papers on space technology and space astronomy were published. In 1986, the space environment field was added, followed by space applications in 1989 and space exploration in 1995. Papers classified as others were

**Table 2.** Number of articles according to subject

	Subjects	Contents	Number	Total
1	Space environment	Sun (or solar)	43	231
		Magnetosphere	63	
		Ionosphere	55	
		Atmosphere	30	
		Space-ray	40	
2	Space exploration	Solar system (except earth and sun)	23	65
		Space survey (including asteroids and comets)	16	
		Lunar exploration	26	
3	Space application	Space geodesy	59	117
		Payload	48	
		Application (including microgravity and remote sensing)	10	
4	Space technology	Satellite operation	200	235
		Satellite (including space shuttles and rockets)	35	
5	Space astronomy	Observation instrument	74	448
		General astronomy	328	
		Historical astronomy	46	
6	Other	Education	2	17
		Meteorological (or climate)	15	
Total				1,113

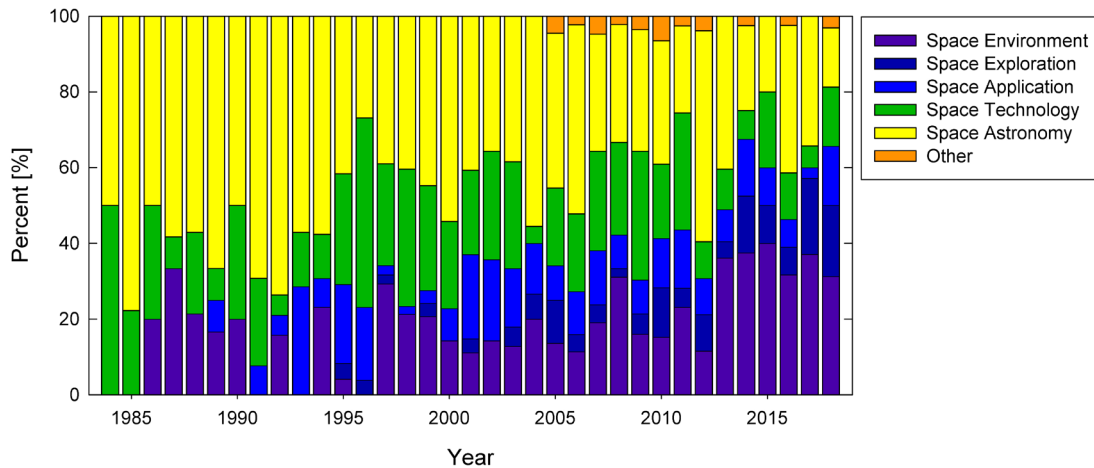


Fig. 5. Yearly distribution of the number of papers according to subject.

added only in 2005.

The field of space astronomy was influential enough to account for approximately 50% of the total papers until the mid-1990s; however, the number of papers in the field has gradually decreased since then (KSSS 2009). Of course, the proportion of papers in space astronomy in 2012 (55.8%) and 2013 (40.4%) suddenly increased, and it is thought that this was related to the increase in the number of articles by foreign researchers after the registration of JASS with SCOPUS at the end of 2011. The period also coincides with the period of publication of a collection of papers in memory of Robert H. Koch (1929–2010) in 2013. Of the papers published recently in 2018, space astronomy accounted for 15.6%.

Space technology accounted for half of the total papers published, with 50.0% in 1984 and 50.0% in 1996, and more than 30% of the total papers published in 1998 (36.2%) and 2009 (33.9%). Interestingly, in 1998 and 2009, the total number of papers of the journal increased. In particular, 2009 was the year when the largest numbers of papers were published since JASS began publication (KSSS 2009). The increase in the number of papers can be presumed to be partly related to papers in the space technology field. Space applications and space exploration tended to increase gradually in the 1990s. In particular, the number of papers on space exploration shows a tendency to increase with a slightly change. In conjunction with national government policy, research on space exploration is expected to continue to increase in the future.

Papers in the field of space environment have been steadily published since the beginning of JASS. In particular, they account for more than 30% of all papers published annually from 2013 to 2018. In 2018, they accounted for 31.3% of the total, which was approximately twice the

number of papers published from the space astronomy field during the same period. Papers in the field of space environment have shown a tendency to increase overall with a slight increase or decrease in each period. In addition, because the mass media is increasingly interested in the space environment, the proportion of this field is expected to continue to increase.

The other field was categorized beginning in 2005 since the first publication of this category. JASS concluded a joint agreement with the IESO on May 12, 2006, arranged the joint hosting of the International Year of Astronomy academic conference on April 28, 2009, and joined the Korea Geoscience Union (KGU) on April 29, 2010. These periods of lively internal and external activity coincide with the period when papers in other field began to be published.

Astronomy education academies for children (e.g., children's observatory, junior astronomy schools, Geokuro observatory) are representative examples of astronomy-related projects currently in operation nationwide. These projects are attempting to cultivate interest by integrating astronomy with education. Therefore, JASS can broaden its versatility by expanding its publication scope to astronomy education (or space science education) and the acceptance of related papers.

Table 3 shows the correlation between the number of articles per year and the number of articles per research theme. Overall, the total number of papers in the field of space astronomy has been found to affect the total number of papers. The correlation value of the space astronomy field with overall is 0.56, showing a higher correlation than other fields. In the overall trend of distribution, the papers in this field of space astronomy are decreasing, and this coincides with the decreasing trend in overall number of published papers in the journal.

**Table 3.** Correlation between the number of papers per year and number of papers per subject

	Space environment	Space exploration	Space application	Space technology	Space astronomy	Other
R <sup>2</sup>	0.43	0.10	0.17	0.43	0.56	0.29

Therefore, JASS should take urgent measures to counter this decrease. Currently, the space environment field is showing an increasing trend (see Fig. 5). The space astronomy field, which has been the main research area of JASS, is being replaced by the space environment field. In this situation, it would be wise to take measures to ensure that the space environment field is well established as the main field. In addition, when constructing a roadmap for the future, areas other than space environment should also be considered. This planning is a necessary process to balance the various fields of research in JASS.

**3.3 Analysis of Authors and Their Affiliations**

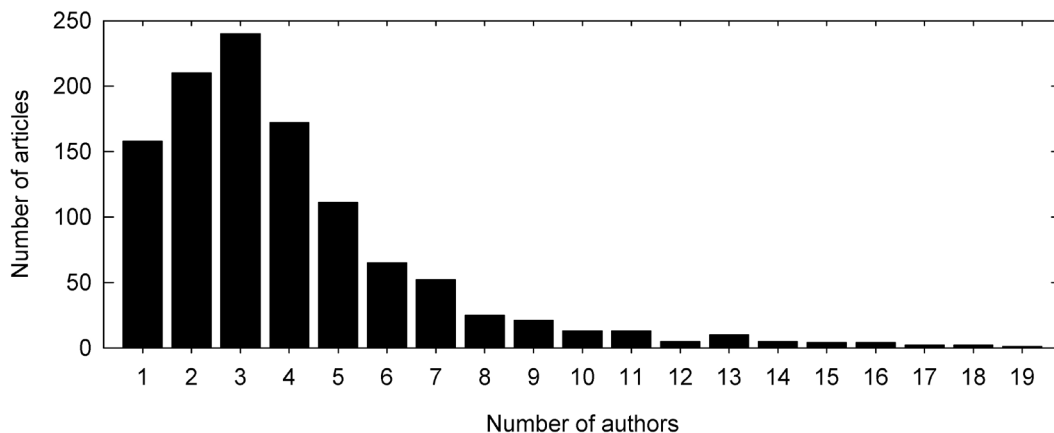
Fig. 6 shows the number of published articles according to the number of authors. There have been 158 articles published by single authors, accounting for 14.2% of the total, while 210 articles were written by two authors, accounting for 18.9% of the total. The highest number of articles, as many as 240 articles, were written by three authors, accounting for 21.6% of the total. The rest (50%) were written by four or more authors. The number of authors specified in 1,113 articles is estimated to be 4,429 in total assuming overlap. This means that approximately four authors are engaged in the completion of one article. The article with the highest number of authors was “Performance Analysis of the First Korean Satellite Laser Ranging System” (Choi et al. 2014), which was published in Volume 31, Issue 3, 2014. It is confirmed that a total of 19 researchers from the Korea Astronomy and Space Science Institute and Chungnam National University participated in

that study.

To determine the specific authors engaged in articles, only lead authors who were the first author or corresponding author of the paper were selected. It is confirmed that 542 lead authors were engaged in writing 1,113 articles published in JASS. The average number of articles published by lead authors is 2.1. Among the 542 authors, the lead authors who published one article is confirmed to be 330. This means that about 60.9% of lead authors publish only once in JASS. The fact that more than half of researchers publish only once should be addressed as an important issue to consider with respect to the prospects of JASS.

Among the 542 lead authors, only 39.1% are confirmed to have published more than two articles. Researchers who published more than 10 articles in JASS as lead authors numbered 23 in total. In particular, the aggregate number of articles written by the top five researchers participating as lead authors is 139. This figure accounts for 12.5% of the total 1,113 articles. This can be considered a meaningful result, showing that some researchers consistently publish their work, even though many stop publishing their work after submitting once. To prevent this practice, we must provide convenient measures for researchers to encourage continual publication.

Fig. 7 presents a histogram of the annual distribution of articles by year published by foreign authors (including both lead authors and co-authors). They are identified by the names of authors and their affiliations; thus, there may be some errors, but they are judged not to have much impact on the analysis. Foreign researchers were engaged in 148 of 1,113 articles, accounting for 13.3% of the



**Fig. 6.** Distribution of the number of papers according to the number of authors.



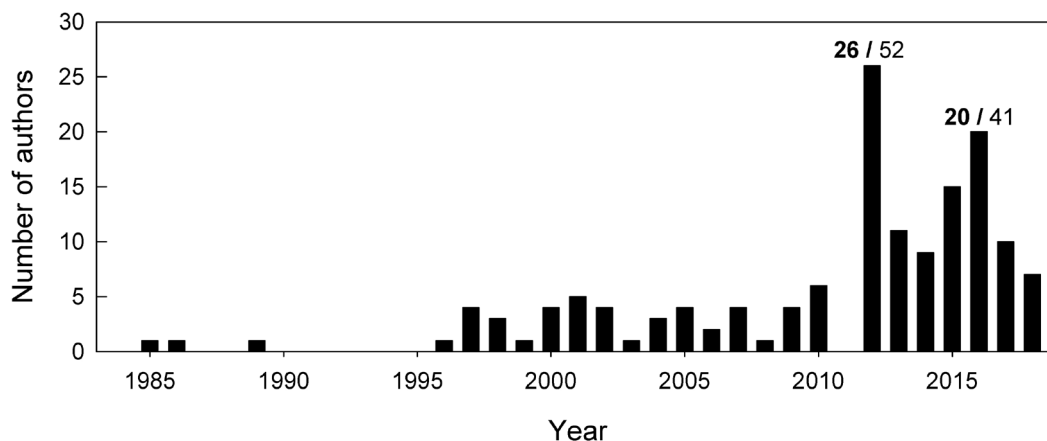


Fig. 7. Yearly distribution of the number of papers by foreigners participating as co-authors.

total. Ten years ago, the average percentage of foreigners participating in domestic journals corresponding to SCI(E) was approximately 22.0% (Kim & Chung, 2010); thus, in comparison, the foreign-born participation rate for JASS is low. Fortunately, after the journal was indexed by SCOPUS in late 2011, there was a sharp increase in the foreign-born participation rate. On average, the participation rate of foreigners since 2012 has been greater than 20%. In particular, the number of articles published in 2012 was 52, among which 25 articles (50%) included foreign researchers. The number of articles published in 2016 was 41, among which 20 articles (48.8%) included foreign researchers. Despite the total number of published articles decreasing by year the participation rate of foreigners has remained at 20% since 2012. This can be interpreted as promising because it shows that the international influence is growing, even if the total number of articles has diminished. The continuous reduction in articles including foreigners, however, can have a negative impact on their participation in the future; thus, some measures are needed to encourage these foreign researchers to participate more (Shin 2011).

Most authors (including co-authors) who publish their articles in JASS are affiliated with one institution; however, some authors work with more than two institutions. There are 255 affiliated organizations, both at home and abroad. They can largely be divided into three organizations: educational, research, and industrial.

Educational institutions include universities and research centers of universities. Some of the researchers are middle and high school teachers, and their affiliations fall into the category of educational institutions. There are 132 educational institutions, making up 51.6% of the total, and they are the most widely mentioned. The most widely mentioned educational institutions are Yonsei University (769), Chungbuk National University (527),

and Korea Advanced Institute of Science and Technology (276). Research institutes refer to national organizations whose main purpose is to conduct research. The number of research institutes is 96, accounting for approximately 37.5% of the total. The research institutes with the greatest mention are the Korea Astronomy and Space Science Institute (906), the National Astronomical Observatory (423), and the Korea Aerospace Research Institute (365). Here, the title of National Astronomical Observatory has been used by some researchers since 2000, but it refers to Korea Astronomy and Space Science Institute. This study distinguishes between Korea's Astronomy and Space Science Institute and the National Astronomical Observatory; however, it is important to know that they refer to the same institute. There are 28 industrial organizations, accounting for 10.9%. The most widely mentioned industrial organizations are SaTReC (15), SELab (14), and AIT (7).

In addition, the entry of "deceased" can be found in some papers, which means that the author had already passed away when the article was published. Such entries can be found in three articles, and we confirmed that this was the case for American astronomer Robert H. Koch (1929–2010) (Kim et al. 2010; Ambruster et al. 2012; Koch et al. 2012). Three articles were included in papers published by KSSS in memory of him in 2010 and 2012 (see also KSSS 2012).

### 3.4 Changes in Overall Organization of Papers

The papers of Volume 1, Issue 1, in 1984, were based on the basic structure of introduction, main body, and conclusion. In the first part of each paper, the research title, researcher's name, and affiliation were briefly mentioned. The date of receipt (submission) of papers in parentheses was recorded under the affiliation part. In 1984 and 1985, only the receiving date of the paper was recorded, while the

confirmation date was added in 1986. In 1988, the address of the affiliated institution began to be briefly specified. In 1994, e-mail addresses of authors began to be included. Some authors did not indicate their email addresses, but most lead authors and co-authors specified theirs. In 2000, from the second issue of Volume 17, keywords began to appear in abstracts. At the same time, lead authors began to be classified as single authors and co-authors. After this change, the journal was selected as a KCI-indexed journal by the research foundation by the end of 2001. Prior to being selected, there had been some changes in the font size and design applied to papers each year. These various changes seemed to result from a lack of precise rules on the organization of papers. From 1984 to 2001, there was no change in the basic structure (introduction, main body, and conclusion); however, the specific description of the name and affiliation of the author experienced subtle changes.

We also checked the size of the journals from the first Volume of JASS. The first Volume (1984) had a format size of 175 mm × 247 mm, while the second Volume (1985) had a size of 176 mm × 248 mm. From 1986 to 2009, the size of publications was in the range of 186–190 mm in width, and 252–261 mm in height. The first issue of Volume 15 (1998) has the size of 186 mm × 252 mm, but the second issue of Volume 15 (1998) was 189 mm × 259 mm. Journals published before 2010 did not have a certain standard, nor did they exhibit trends. Since Volume 27 (2010), the size has been fixed to 210 mm × 280 mm.

JASS has also experienced change in the cover design. The table of contents was located on both sides of the cover during 1984 to 2007, usually written in Korean, on the front and in English on the back. In Volume 25 (2008) and 26 (2009), only the back of the cover page contained a table of contents, which was written in English and in Volume 27 (2010), only the front of the cover page contained a table of contents, which was also written in English. From Volume 28 (2011) to the present, the cover was designed without a table of contents on the cover.

Until 2001, the organizational structure of papers changed little-by-little; it did not show drastic change and maintained its overall composition until 2010. However, there have been many changes since 2010. First, since JASS Volume 27 (2010), the Korean language has been excluded as an official language of the journal, and the regulations have been changed to only accept papers in English. On June 9, 2010, JASS was assigned an ISSN number, and in that same month, a new JASS design was introduced. Previously, a single-layer format had been adopted; however, beginning with Issue 28, the title, author's name, affiliation, and abstract were written on a single layer, and a separate

layer was implemented starting with the introduction. The e-mail address and telephone number (or fax number) corresponding to the author's personal information were entered at the bottom as comments, and only the personal information of the corresponding author was entered. In the upper left part of the paper, brief information such as volume, issue, page number, and DOI (Digital Object Identifier) number of the paper were written, and the logo of JASS was inserted on the right side. Previously, only the date of receipt of the paper and the date of confirmation were mentioned, but as of the new update, the date of revision was also specified. Since 2015, the ORCID (Open Researcher and Contributor ID) of lead authors has begun to be specified. This organizational restructuring of the journal is developing.

In the first Volume of JASS, the authors presented references in various formats. In general, they were presented in the order of author's name, title of paper, journal name, volume, first and last page numbers, and year of publication. From the second volume of JASS, the year of publication was included between the author's name and the title of paper. From Volume 3 (1986) on, the title of paper was excluded in the reference. There was one exception in Volume 6 (1989); in this issue, the title of paper was included in the references by some authors. It seems that there was no strong rule regarding the references. Subsequently, they were presented in the order of author's name, year of publication, journal name, volume, and first and last page numbers until the first issue of Volume 27 (2010). Beginning in the second issue of Volume 27 (2010), DOI was added to the end of the list in the references. Beginning with the first issue of Volume 28 (2011), the format of references changed once more. The title of paper was again included in the list of references, and the year of publication was presented in parentheses. Finally, the format was established in the order of author's name, title of paper, journal name, volume, first and last page numbers, (year), and DOI.

From 1984 to the present, the overall structure of the journal has changed, developing into what is now considered as that of an international academic journal. Nevertheless, there is a need to improve the structure of papers. The area that requires improvement is related to the keywords of abstracts, which began to be included from the second issue of Volume 17 (2000). The present rules on abstract keywords state that they should be composed of 3–6 words or sentences written at the end of the abstract as one line; that is, only the number of words that can be used as keywords is mentioned. The advantage of this is that the research scope of JASS publications is expanded, owing to the free choice of keywords being allowed. However, this

may cause problems in other respects.

The problem with keyword entry is that many terms with similar meanings are used, resulting in missing examples in the search process. For example, in a search for research articles on binary stars depending on the perspective of the researcher, terms such as near binary, near binary star, contact binary, contact binary star, near-contact binary, near-contact binary star, eclipse binary, eclipse binary star, eclipsing binary, and eclipsing binary star can be used as keywords. For grammatical reasons, these terms can also be plural, depending on the number of research subjects. Therefore, the terms used are varied, depending on the research perspective and purpose, but may contain similar meanings. However, when one actually performs a search, although the terms are similar keywords, they appear as separate in a search. In addition, the full expression of the keywords and abbreviations of keywords also appear as separate entries. For example, if we search GPS, the abbreviation for the term “Global Positioning System,” papers with Global Positioning System as keywords are not searched under the keyword GPS. This leads to the result that the search for papers includes some articles but not others relevant articles, which is not in balance and does not match the purpose of the search.

In most international journals, it is stipulated that when selecting a keyword, the closest one within the scope of the limited terms specified for each research topic is to be selected and recorded. This stipulation may seem to deprive authors of free keyword choice, but it provides a very efficient system in that searchers are able to find more information easily. Currently, the publishing of offline journals is decreasing, and the online publishing of journals is increasing. The exchange of information and knowledge via online journals is currently active (Shin 2011). In this age, the keyword system for searching must be reorganized and taking measures to enable the use of JASS efficiently.

#### 4. DISCUSSION

Founded on May 19, 1984, KSSS launched JASS on September 30 of the same year. In 1984, Volume 1, Issue 1 of the journal published six papers, beginning with a paper by Prof. Kyong Chol Chou (1929–2010) of Kyung Hee University.

JASS published 1,113 articles for 35 years (1984–2018). It began to increase gradually in the 1990s with a slight increase and decrease in between and in 2009, the largest number of papers was published, amounting to 59. However, the number began to decrease gradually after 2009, and it

still shows a decreasing tendency. We confirmed that the impact factor has been improving, despite the decrease in quantity. However, considering that the average self-citation ratio is 78.3%, the variation of the impact factor is not easy to predict. Therefore, JASS must take measures to improve the impact factor but reduce its fluctuation.

JASS, which used to permit a mixture use of Korean and English publications, showed an increasing frequency of Korean articles since the mid-1990s, corresponding with a general increase in the number of articles. Since the official language of the journal was set as English in 2010, there have been positive outcomes with regard to registration with SCOPUS, but the total number of published articles began to decrease and is still decreasing. The use of English enabled the journal to become an international one; however, the change was radical, not considering the domestic readership. With respect to this limitation, we propose that KSSS launch a new academic journal that accepts papers written in Korean. If an academic journal is launched to enable the Korean language to draw the interest of domestic readers and facilitate access to information, it would also be effective in promoting KSSS and JASS. The Korean Astronomical Society also manages JKAS, an English journal, and PKAS, a journal that includes texts in Korean. The Korean Meteorological Society also manages APJAS, an English journal, and *Atmosphere*, a journal that includes texts written in Korean. It is expected that KSSS would also have positive results from a long-term perspective if it were to launch a journal in which Korean-language papers can be published, considering the cases of other academic societies.

The field of space astronomy has affected the variation in the total number of papers per year, accounting for more than 50% of the papers published in JASS until the mid-1990s. However, since the year 2000, the number of papers in the field of space astronomy has declined, eventually to 15.6% of the total papers published in 2018. The space environment field, however, has had papers published annually since 1986 and has increased its proportion to more than 30% of the total papers published each year since 2013. In addition, the number of papers in the space environment is showing an increasing trend, with a slight fluctuation. The increase shows that the space astronomy field, which was the main field of JASS, is being replaced by the space environment field. With this change, we propose that JASS maintains its reliability and stability as an academic journal and designs a roadmap for the space environment field, such that the process of replacing the main fields may proceed smoothly.

Currently, there are educational institutes related to

astronomy among the increasing number of private education institutes. The movement to integrate education with astronomy can be identified in these private educational institutions. In addition, there are an increasing number of cases of teachers and students writing papers in science education based on experiments and research as extracurricular activities in specialization high schools. Currently, since JASS became a National Research Foundation of Korea registration journal, it has shown interest in education and public projects and has been working with various related organizations to maintain this connection. In addition, articles related to education can be found in items classified as other in the JASS categories. In consideration of this background, we expect JASS to broaden its versatility by positively accepting educational papers reflecting space astronomy and adding space education fields as research themes.

Among the authors who participated in the 1,113 papers published in JASS, 542 were lead authors (first author, corresponding author). Of these, 60.9% of the researchers identified that they had published in the journal only once. These results show that it is necessary to encourage the publication of research papers, not just once, but through fundamental support such as providing a research environment where the research of members can be actively conducted and exchanged. In addition, adding new fields such as space education, or launching new journals that accept Korean-written papers will contribute to reducing the percentage of researchers who publish only once in the journal, because these measures can expand the direction and scope of JASS.

The percentage of foreign researchers participating in JASS is 13.3% (148 papers), which is relatively low. Fortunately, the number of foreign researchers has remained above 20% since 2012, after became a SCOPUS registration journal. Although the number of publications per year is decreasing, maintaining the participation rate of foreign researchers at greater than 20% is very encouraging, in that it shows the possibility of JASS becoming an internationally recognized academic journal. In the future, JASS must formulate a policy to increase the participation rate of foreigners. In this regard, a concise system for submitting articles, a rigorous screening process, and a prompt editing process would serve as effective means to attract foreign researchers. Therefore, we suggest considering the improvement of computer systems.

Most international journals establish select keywords closest to the research topic within the range of prescribed keywords for inclusion with an abstract to be published in a journal. This keyword system can be very effective when

a reader is searching and using the data. However, since JASS does not have a limited range for abstract keywords, words with similar meanings are classified as separate words or further specified according to the point of view of the researcher. For this reason, data retrieval based on keyword setting in JASS is inefficient. Therefore, in JASS, it is necessary to construct an efficient keyword search system by constructing a list of research topics for determining keywords, adopting methods such as unifying various terms with the same meaning into one term. This construction will greatly affect the growth of JASS by enhancing its accessibility to readers.

JASS has published 1,113 papers over the past 35 years. It became a SCOPUS-indexed journal after becoming a registered journal in KCI, run by the National Research Foundation of Korea; it has also recently been selected as an ESCI-listed journal. It is a very proud achievement that the journal has been published consistently for 35 years. Significant effort will be required to make the leap forward as an influential international journal. A simplified submission system, rigorous and impartial review process, and prompt editing process are some of the necessary goals to provide a supportive submission environment for researchers both at home and abroad. With these goals in mind, developing a future roadmap in detail and responding to changing trends will facilitate development into an international journal. In addition, the status of Korean astronomy in the international community will be raised if we maintain a strong cooperative network with the Korean Astronomy and Space Science Institute and the Korean Astronomical Society, which are closely related to JASS. We expect that JASS has an important role to play in the development of modern astronomy in the future.

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