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A Brief Bibliometric Survey on Circularly Polarized Antennas for Mobile Communication

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ABSTRACT

This paper presents a database review on "Circularly Polarized Antennas for Mobile Communication" as it is the emerging technique used by mobile service provider because of having benefits over other types of antennas available.The polarization purity is now the major issue. In some cases due to cross polarization issue the antenna signal is cancelled at receiver side.So, it is necessary to have circularly polarized antenna to avoid this polarization issue because of change in phase of signal. The change in phase of signal is due to striking of wave on the obstacles and it slightly tilted from its direction causes cross coupled radiation at receiver's side. The phase change causes loss of signal as the wave is directly cancelled by the receiver antenna. The necessity of doing this bibliometric survey is that to know how the circular polarization is advantageous for today's mobile communication systems and its practical usability.This paper shows the importance of circular polarization antenna from the year 1992 and continued upto the present date. The database analysis of the antennas is done through Scopus, Google Scholar and tools like Gephi and GPS Visualizer etc.Through this database survey it is revealed that maximum number of publications are from conferences and journals, affiliated to engineering, Chinese lead publications followed by Japan and then India. Axial ratio bandwidth is the second important parameter. For gain and radiation pattern keywords, after the engineering computer science is the most contributing subject area and least contribution in terms of review papers is also found.

***Keywords**: Database Analysis, Circular Polarization, Antennas, Axial Ratio Bandwidth, Polarization Purity, Feeding Methods, Gain, Radiation Pattern Etc.*

1. INTRODUCTION

During the development of smart wireless systems and radar communication systems the circularly polarized (CP) antenna become more and more popular, hence much usable than linearly polarized antennas as it has many limitations (Ullah, Ain & Ahmad, 2017), (Cai, Ming, Li, Yin and Hu, 2014).The circularly polarized antenna reduces the multipath propagation effects to mitigate the polarization mismatch issue during transmission and reception (Rui, Li, Yang, Wei and Qi, 2017), (Ding, Gao, Yu and Xu, 2015). By optimizing on the polarization mismatch issue it is possible to enhance the capacity of antenna in order to improve the data transmission rate. Basically, there are three types of polarization such as linear polarization, elliptical polarization and circular polarization (Toh, Cahill & Fusco, 2003). The circular polarization has many advantages (Saini, Dwari, 2016), (Li, Zhnag and Feng,2013).than other polarization methods so it mostly used in short range inter BTS communication where there is communication between the customer and small tower called as BTS. The inter BTS communication is necessary because many times transmitted signal is striking on some objects like long buildings, small terrains etc. that causes multipath fading issue. This causes loss of signal in linearly polarized antennas (Gao & Luo, 2014). So, along with linearly polarized antennas the circularly polarized antennas are required during inter BTS communication. The main advantage of using linearly polarized antennas is having very high gain than circularly polarized antennas (Gao & Luo, 2014), (Kumar, Harish, 2013). The circularly polarized antennas having low gain because of circular radiation type structure. The main objective of this survey paper to show how much improvement in circular polarized antenna is done by different researchers in terms of gain and axial ratio bandwidth (Chandu and Karthikeyan, 2017), (Wu, Mu, Zhao and Jiao, 2008) The axial ratio bandwidth is a key parameter in developing circularly polarized antennas (Yue Li & Zhining, 2012), (Ding, Nie and Liu, 2016). The axial ratio parameter should be good enough in order to improve the radiation pattern of antenna (Xu, Li, Wei, and Yang, 2016). Most of the researchers are working on these parameters to give complementary solution to other types of antenna. The objective of all researchers is to enhance the gain and axial ratio bandwidth of antenna (Li, Chen, Qing, Zhang, Xu and Feng, 2012), (Han, Cang and Zhong, 2016).This paper explains a brief bibliometric study on circularly polarized antenna in section 2 formulated by preliminary collection of data about circularly polarized antennas. Section 3 & 4 undertaken to give bibliometric analysis. Limitations of the study in section 5 followed by future scope in section 6 along with the final concluding remarks and mentioned references at the last.

2. PRIMARY DATABASE COLLECTION

There are two types of publication data that can be gathered through open access method and paid access method. You can collect these publications data from their library portals available in universities and by paying or registering independently on different web sources available. Although, there are several popular methods to access the data from supporting databases. Popular author publication resources are Scopus, Web of Science, SCI-mago, Mendeley, Science Direct, Google Scholar, Research Gate, Researcher-ID and many more.Scopus is the largest peer reviewed and citation database of published research articles in different emerging fields such as science, engineering, technology, medicine, social sciences, arts, and humanities. The paper follows the analysis of Scopus database with the help of different keywords that satisfying the surveying requirement of finding the database on circular polarized antennas in section 2.1.

2.1 FUNDAMENTAL KEYWORDS

Some important keywords related to circular polarized antenna were divided into two major parts of selection viz., fundamental key and other primary key types. For this the idea given in table 1 provides keywords list used for basic search mechanism.

Fundamental-Keyword	"Circularly Polarized Antennas for mobile communication"
Fundamental-Keyword (AND)	Circular Polarization OR Circularly Polarized OR Microwave Antennas OR Microstrip Antennas OR Slot Antennas OR Satellite Communication Systems OR Bandwidth OR Directional Patterns (antenna) OR Mobile Antennas OR Mobile Telecommunication Systems OR Antenna Feeders OR Antenna Arrays OR Electric Impedance OR Polarization

Table 1: Planned structure of keywords assigned
Source: http://www.scopus.com (accessed on 19th DEC 2019)

2.2 BASIC SEARCH OUTCOMES

All these analysis is done through largest database from Scopus. Initially we go through the planned assigned keywords search resulting total of 221 publications. This is then modified to 219 papers by restricting it to English publications only (Table 2).

Sr. No.	Publishing Language	Publications Count
1	**English**	**219**
2	**Chinese**	**2**
Total		**221**

Table 2: circular polarization antennas publications in different languages
Source: http://www.scopus.com (accessed on 19th DEC 2019)

All kinds of supporting published and unpublished papers were considered for analysis. The researchers in circularly polarized antenna research area have more focus on publications in journals\articles. 47.51% of conference proceedings papers were found and 50.22% of journals/ articles were found (Table 3).

Publication Type	Number of publications	Percentage of 221
Journal and Article	111	**50.22%**
Conference Proceedings	105	**47.51%**
Book chapter	3	**1.35%**
Book Series	2	**0.90%**
Total	**221**	

Table 3: Publication types with percentage of published papers
Source: http://www.scopus.com (accessed on 19th DEC 2019)

2.3 PRELIMINARY DATA STATISTICS

The documents are collected from journal papers, conference proceeding, articles etc. for the range of twenty eight years from 1992 to 2020. Statistics for yearly published papers were shown in table 4.The figure 1 gives the graphical representation of the yearly published data from the databases.

Year	Publications Count	Year	Publications Count
2020	1	2003	4
2019	34	2002	3
2018	32	2001	1
2017	21	2000	4
2016	18	1999	2
2015	15	1998	2
2014	14	1997	3
2013	6	1996	6
2012	6	1995	8
2011	6	1994	4
2010	5	1992	1
2009	4	**TOTAL = 221**	
2008	2		
2007	4		
2006	5		
2005	6		
2004	4		

Table 4: Statistics for Year wise publications in relevance with the given keywords
Source: http://www.scopus.com (accessed on 19th DEC 2019)

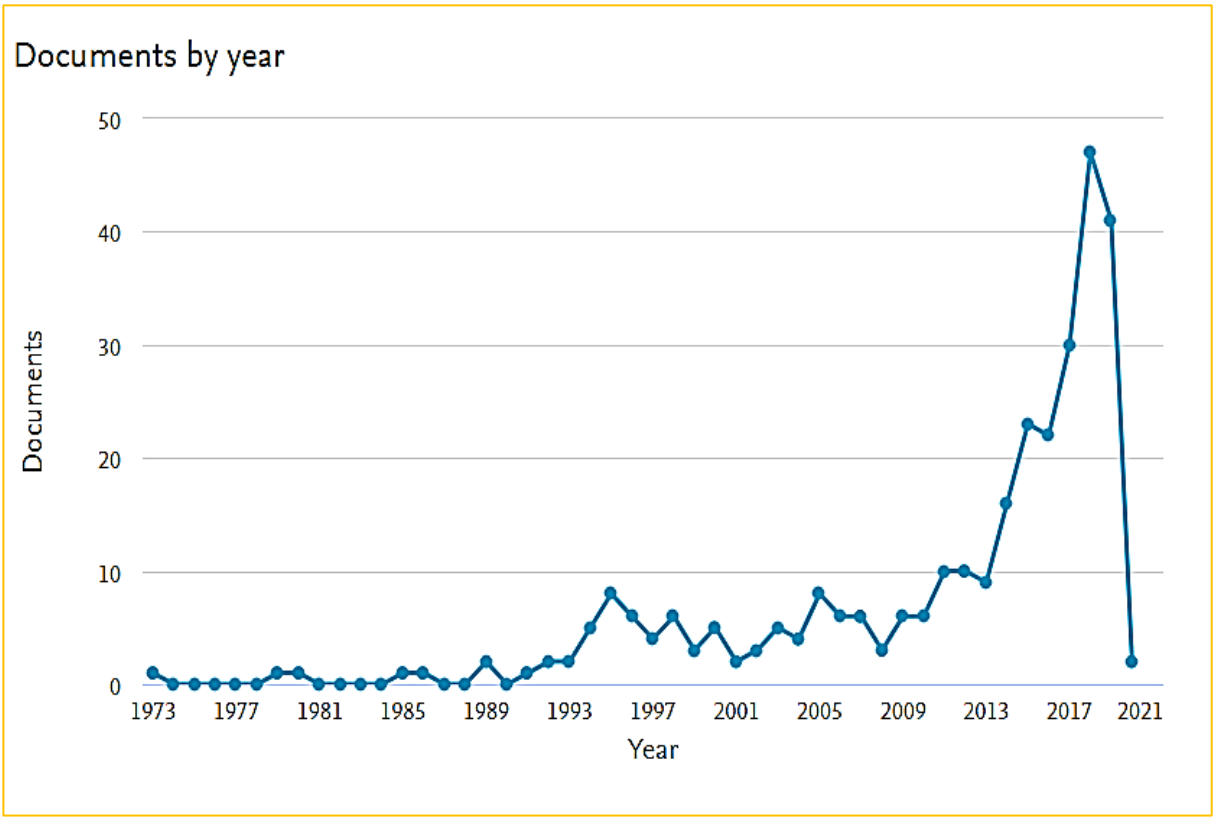

Figure 1: Year wise publishing breakup of circular polarized antenna
Source: http://www.scopus.com (accessed on 19th DEC 2019)

2.4 DATA VALIDATION THROUGH DATABASES

The detailed bibliometric overview was conducted in section 3 to know where the good prominence value of literature, developed original researches and the researchers in the given area by their geophysical area of interest, their affiliation statistics, leading contribution in journals where published articles and their statistics with the brief analysis of citations and research study.

3. PERFORMANCE ANALYSIS OF BIBLIOMETRIC SURVEY

To do a good bibliometric analysis on circularly polarized antennas, there are two usual ways to be applied and these obeys:

- Analysis of geometric region, their networks, and citations received etc.
- Statistics about the keywords, university, prominent authors and best journals to have detailed analysis of data at the popularity level or at the area of interest level.

3.1 GEOGRAPHICAL ANALYSIS FOR DIFFERENT COUNTRIES

Figure 2 is designed using a website named as www.gpsvisualiser.com giving geographical regional locations of more favoured published articles or papers. The aim is to know the dependency of research is more on which specific geometrical area. It is validated from the map that maximum researchers were European citizens.

Figure 2: Geographical locations of countrywide availability of database

Source: http://www.scopus.com (accessed on 19th DEC 2019)

Figure 3 obeys that prominent ten countries having maximum publications in the given area of interest. No doubt that the Chinese researchers will lead by more than 56% followed by Japan with 43% and India with 41% in publications.

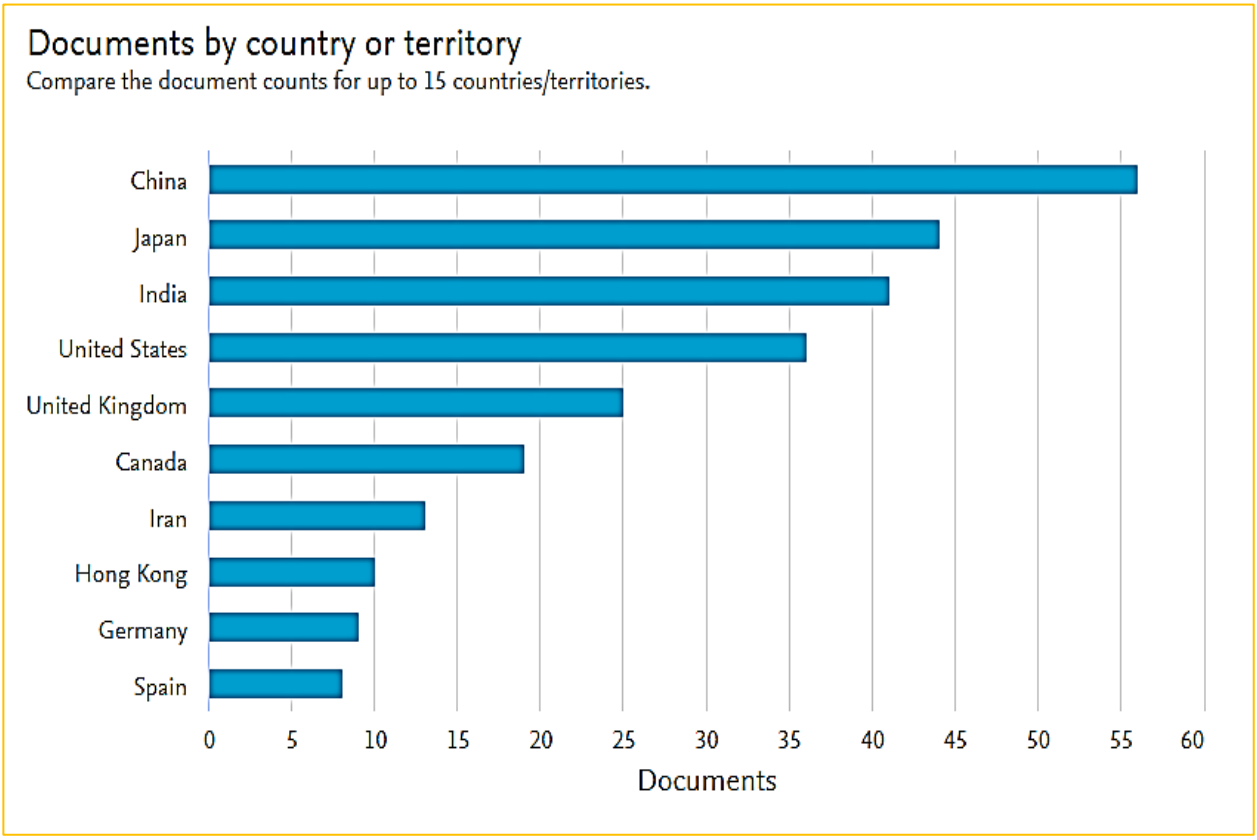

Figure 3: Top ten countries published papers on circularly polarized antennas

Source: http://www.scopus.com (accessed on 19th DEC 2019)

3.2 KEYWORDS ANALYSIS:

Some of the popular keywords are enlisted. The accuracy in keywords gives you the exact targeted count in significant area of research. First ten keywords enlisted in Table 5 by keeping in mind those publications on circularly polarized antennas.

Keywords	Number of Publications
Circular Polarization	27
Circularly Polarized	18
Microwave Antennas	10
Microstrip Antennas	10
Slot Antennas	06
Satellite Communication Systems	04
Bandwidth	04
Directional Patterns (antenna)	03
Mobile Antennas	03

Mobile Telecommunication Systems	03

Table 5: First top ten keywords on circularly polarized antennas
Source: http://www.scopus.com (accessed on 19th DEC 2019)

3.3 ANALYSIS USING NETWORKS

The mutual relation between various types of analytical parameters has presented graphically using network analysis method. "Gephi" is new open source software is used for analyzing the mutual relation among networks. Gephi is a powerful software has capability of filtering, navigating, formulating and collective analysis of networks data. Various Authors uses different keywords, the citations received, their university affiliations, and name of publication title, its year of publication is shown through nodal analysis. In this, for different layout, Fruchterman Reingold and Yifan Hu Proportional were taken into account with various formal adjustments in that. Networks having different parametric analysis for circularly polarized antennas for extracting data from the Scopus databases shown in Figures 4–8. The figure 4 shows there are three different essential data clusters. The data clusters having publisher's keywords and indexed title of 262 nodes and 334 edges.

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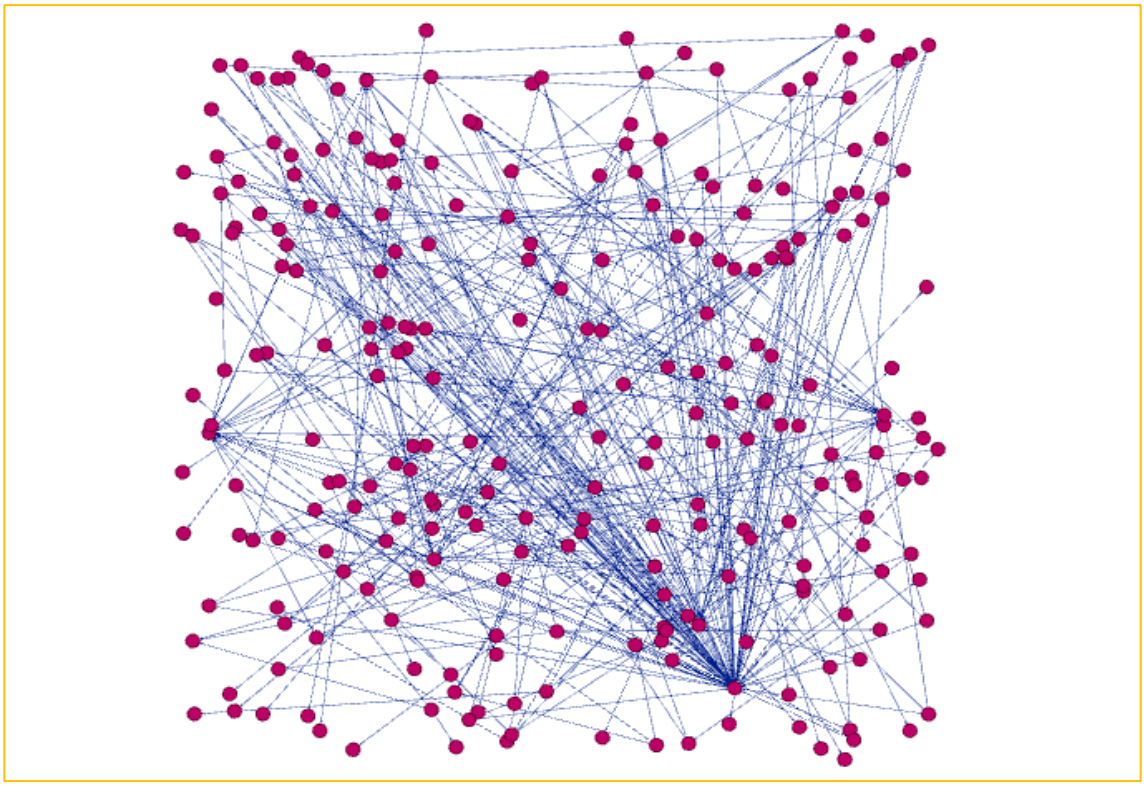

Figure 4: Cluster of various publishers' keywords and their indexed title
Source: http://www.scopus.com (accessed on 19th DEC 2019)

Figure 5 depicts a network for authors and author's keywords appeared in the same paper. Initially,the layout with having 358 nodes and 479 edges. It is found that ‘circularly polarization antennas’ and ‘polarization’ are two top most author keywords that are extensively used in the area.

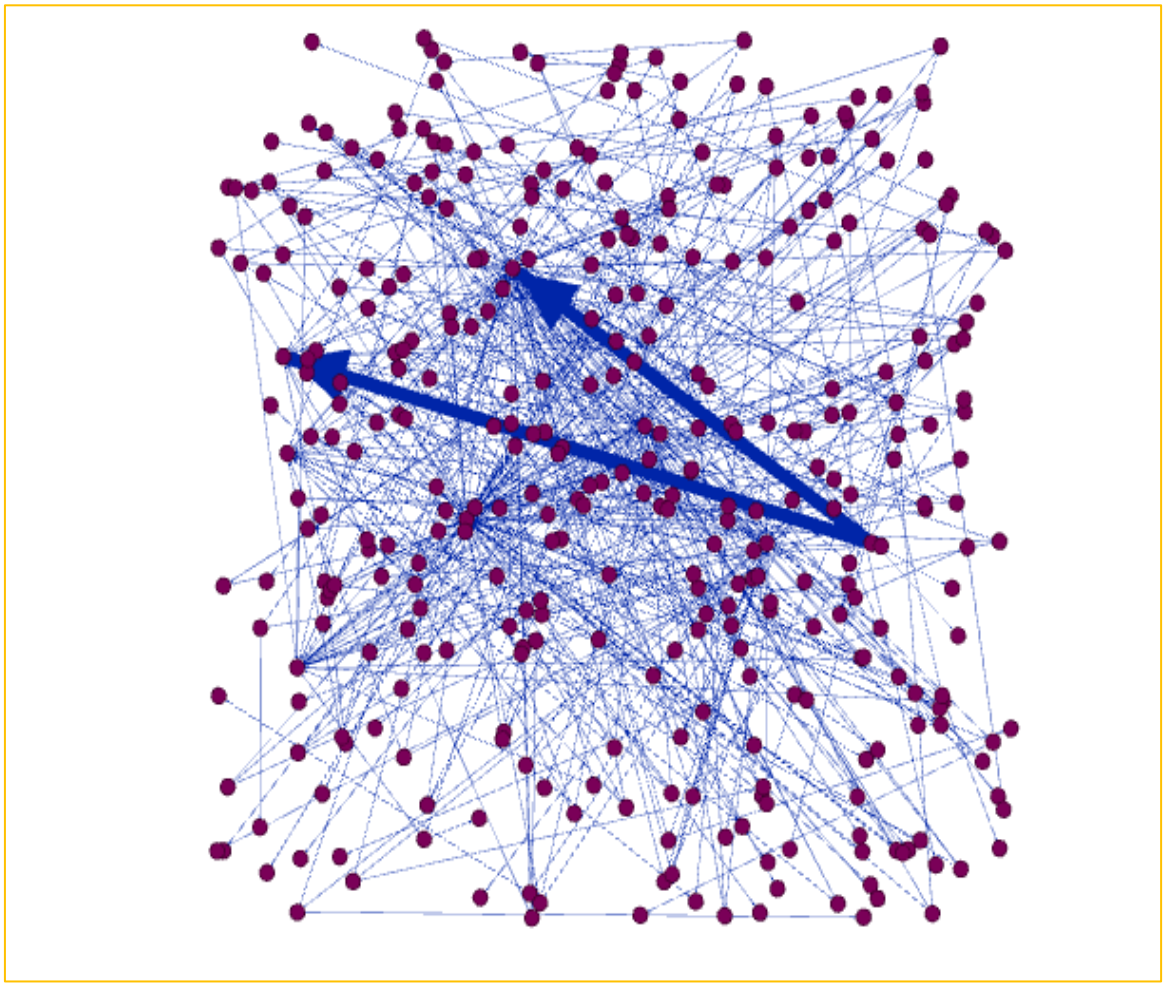

Figure 5: Cluster of authors, keywords, relevance amongst same publications

Source: http://www.scopus.com (accessed on 19th DEC 2019)

Figure 6 shows clusters in the data while clustering networks for author keywords and source title with 282 nodes and 381 edges.

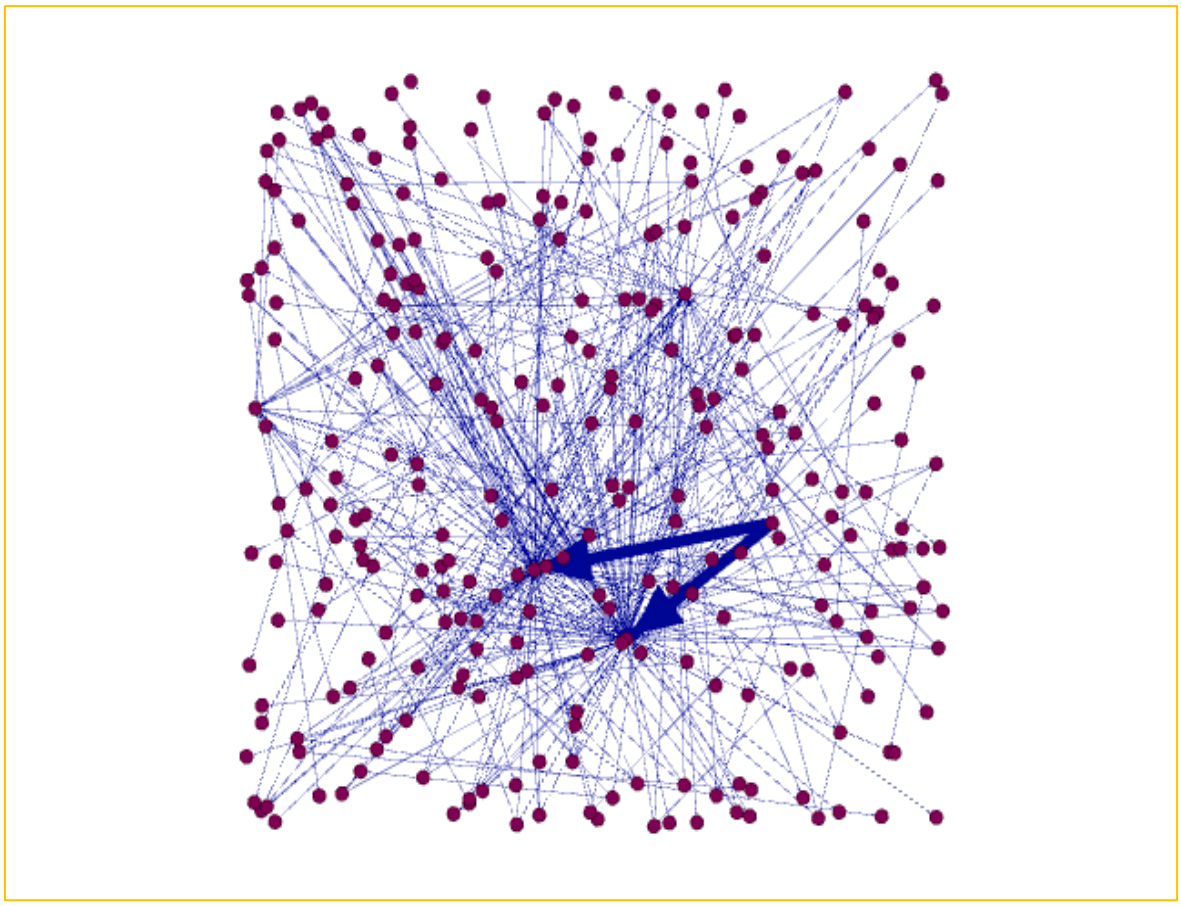

Figure 6: Cluster of authors, source titles, relevance amongst same publications

Source: http://www.scopus.com (accessed on 19th DEC 2019)

Figure 7shows that a cluster of networks found in affiliation, languages, and type with 20 nodes and 12 edges. The actual size of node shows defined affiliation, language, its data type. Maximum publishers were published their work having ‘Engineering' affiliation.

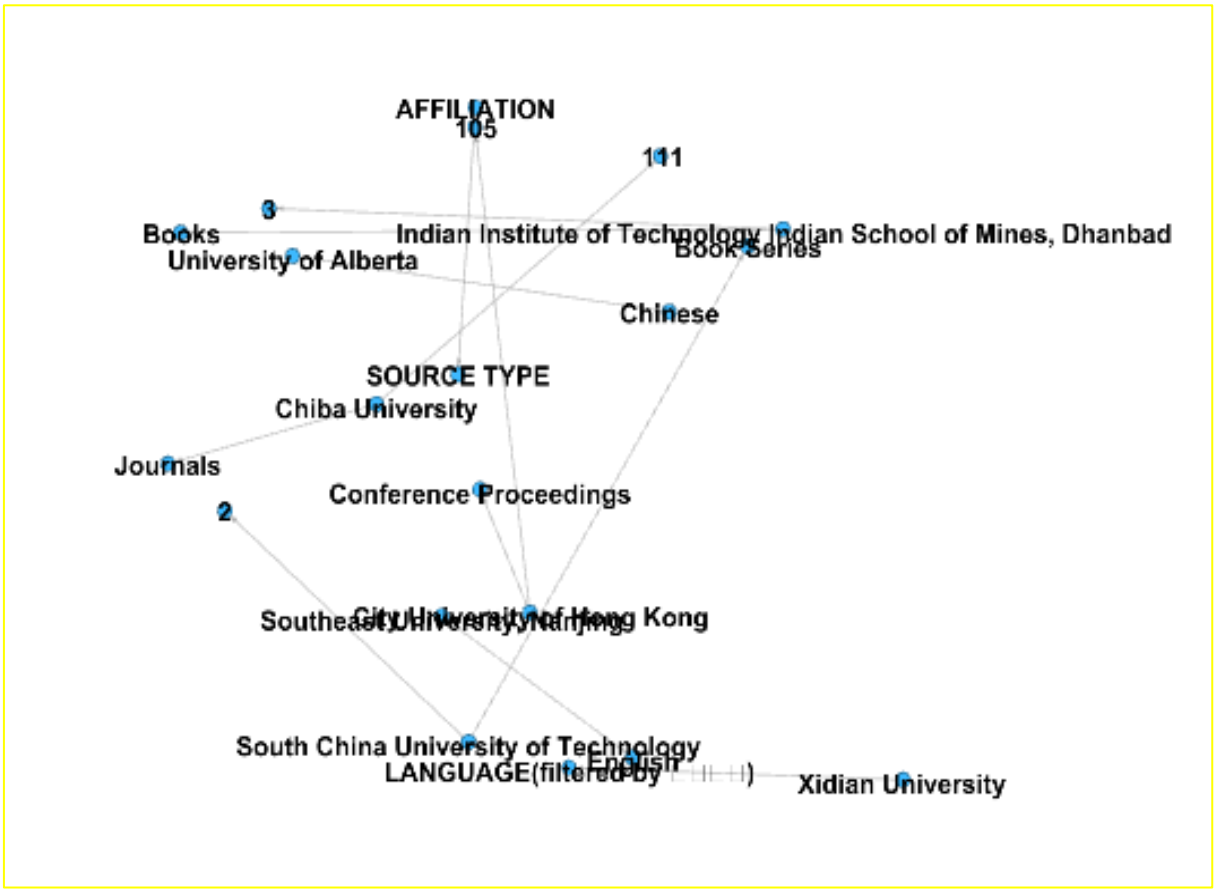

Figure7: clusters of affiliations, languages, and its data type

Source: http://www.scopus.com (accessed on 19th DEC 2019)

3.4 ANALYSIS BASED ON SUBJECT AREAS

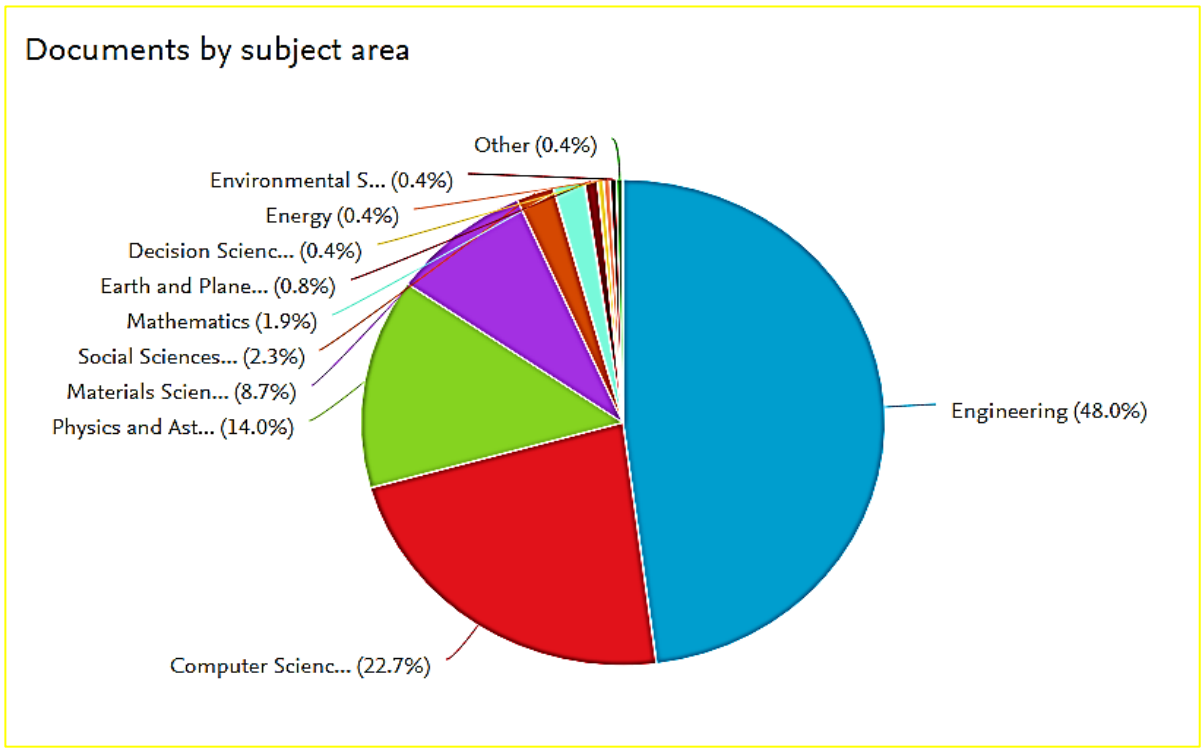

Figure 8: Subjective area wise comparison on evaluated literature data

Source: http://www.scopus.com (accessed on 19th DEC 2019)

Figure 8 shows area wise comparison for evaluated data in circularly polarized antenna publications. It is noted that, from this figure maximum researches follows in engineering and thereby in computer science and physics. It is also noted that least part of research been done by environmental science and energy.

3.5 TOPMOST UNIVERSITIES\AFFILIATIONS

Figure 9 indicates the top ten universities/organizations. Surprisingly, out of that six universities are most contributing to circularly polarized antennas and they belongs to China.

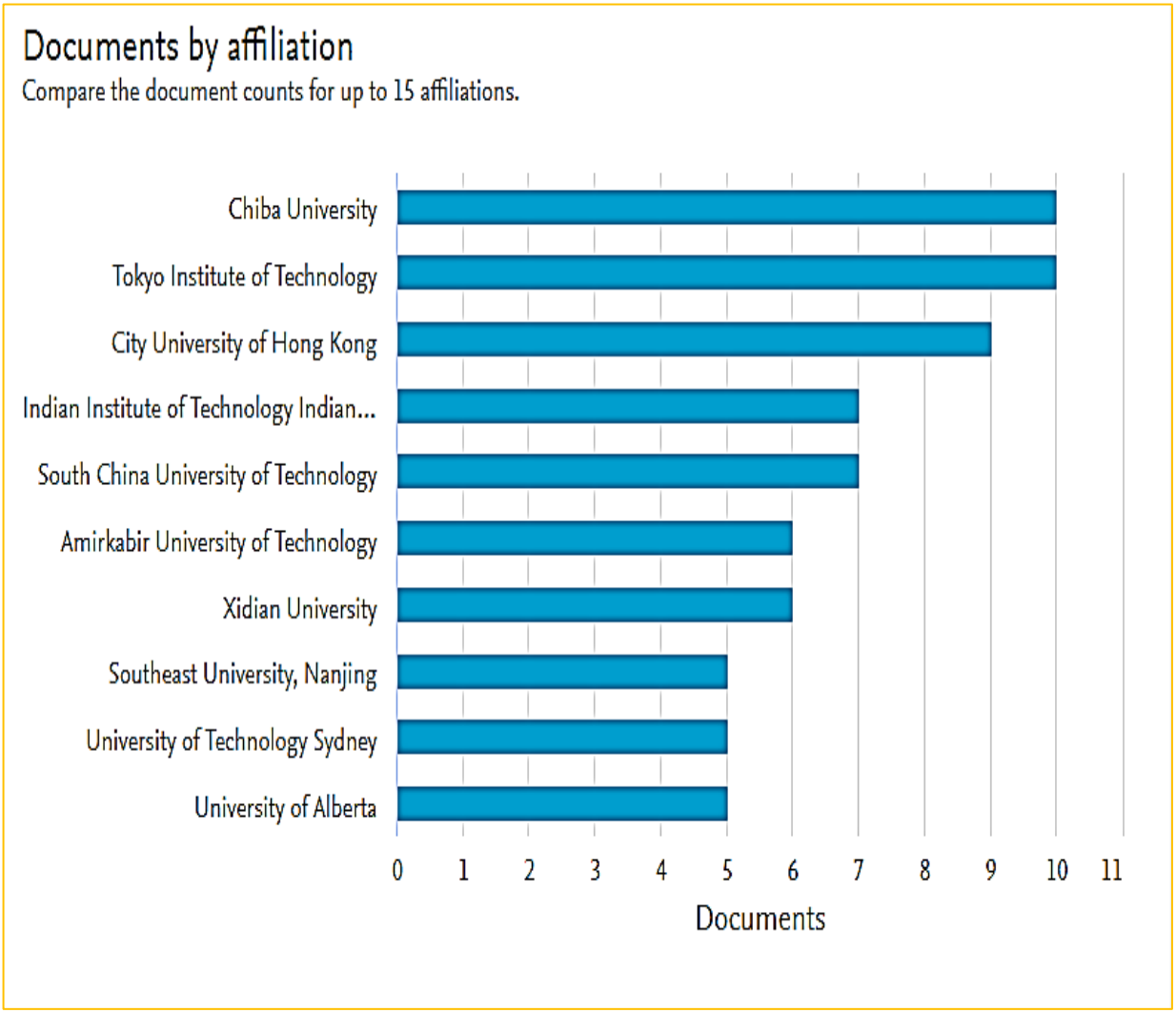

Figure 9: Affiliation statistics on circularly polarized antenna

Source: http://www.scopus.com (accessed on 19th DEC 2019)

3.6 AUTHOR STATISTICAL ANALYSIS

Figure 10 depicts that top ten author contributions in the respective area on circularly polarized antennas to know the research done by a particular author.

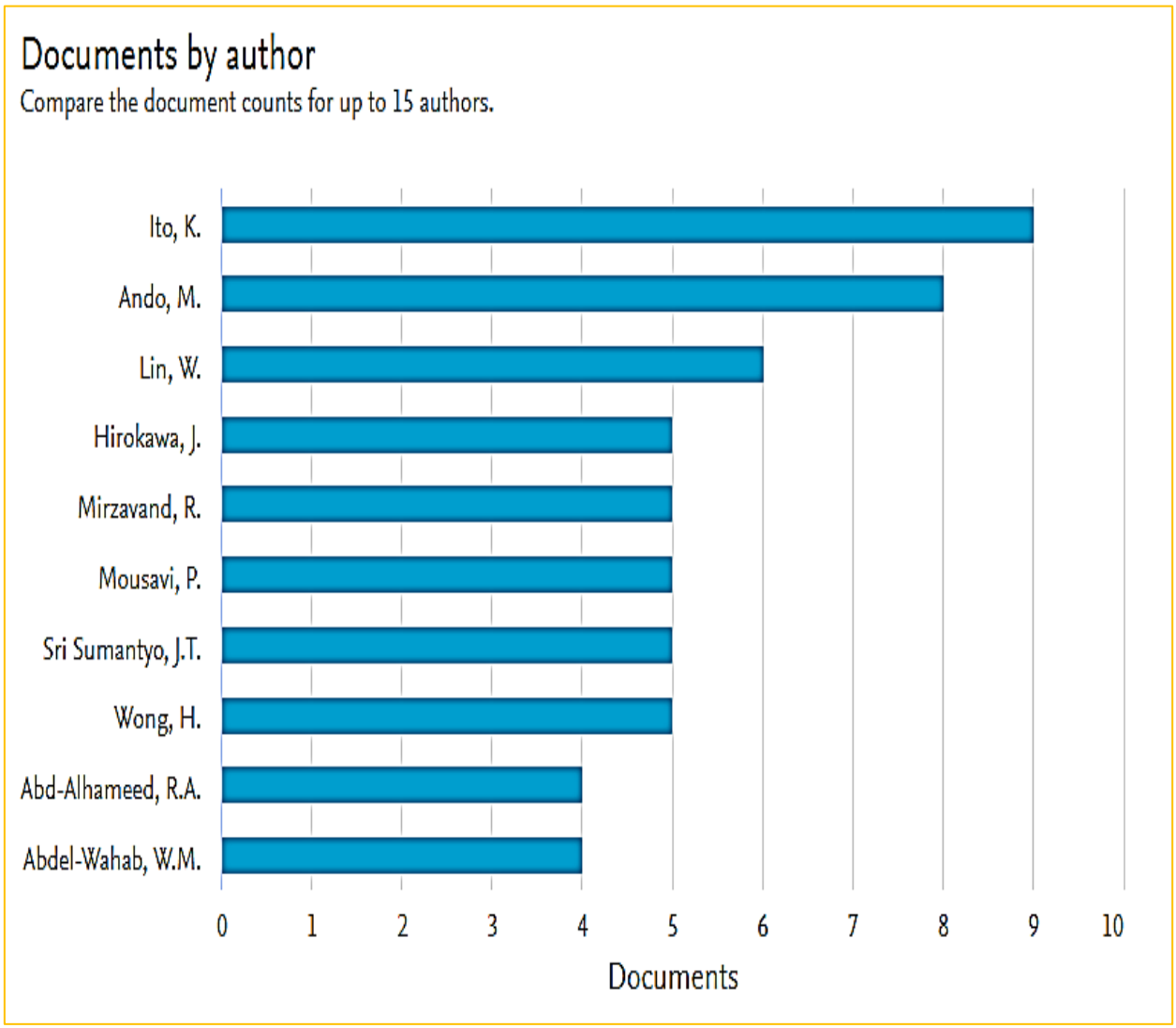

Figure 10: Key Contributor's List

Source: http://www.scopus.com (accessed on 19th DEC 2019)

3.7 JOURNAL STATISTICS FROM DATABASES

Figure 11 defines the publisher's source types in the given area of circularly polarized antennas. The collective gathered data demonstrates that 48.4% of publications are from the articles and 46.4% from the conference papers. Even it is also found that only 3.6% of contributors follow the review papers. This bibliometric review is for showcasing the exact research interest of the researchers in the given areas to be found.

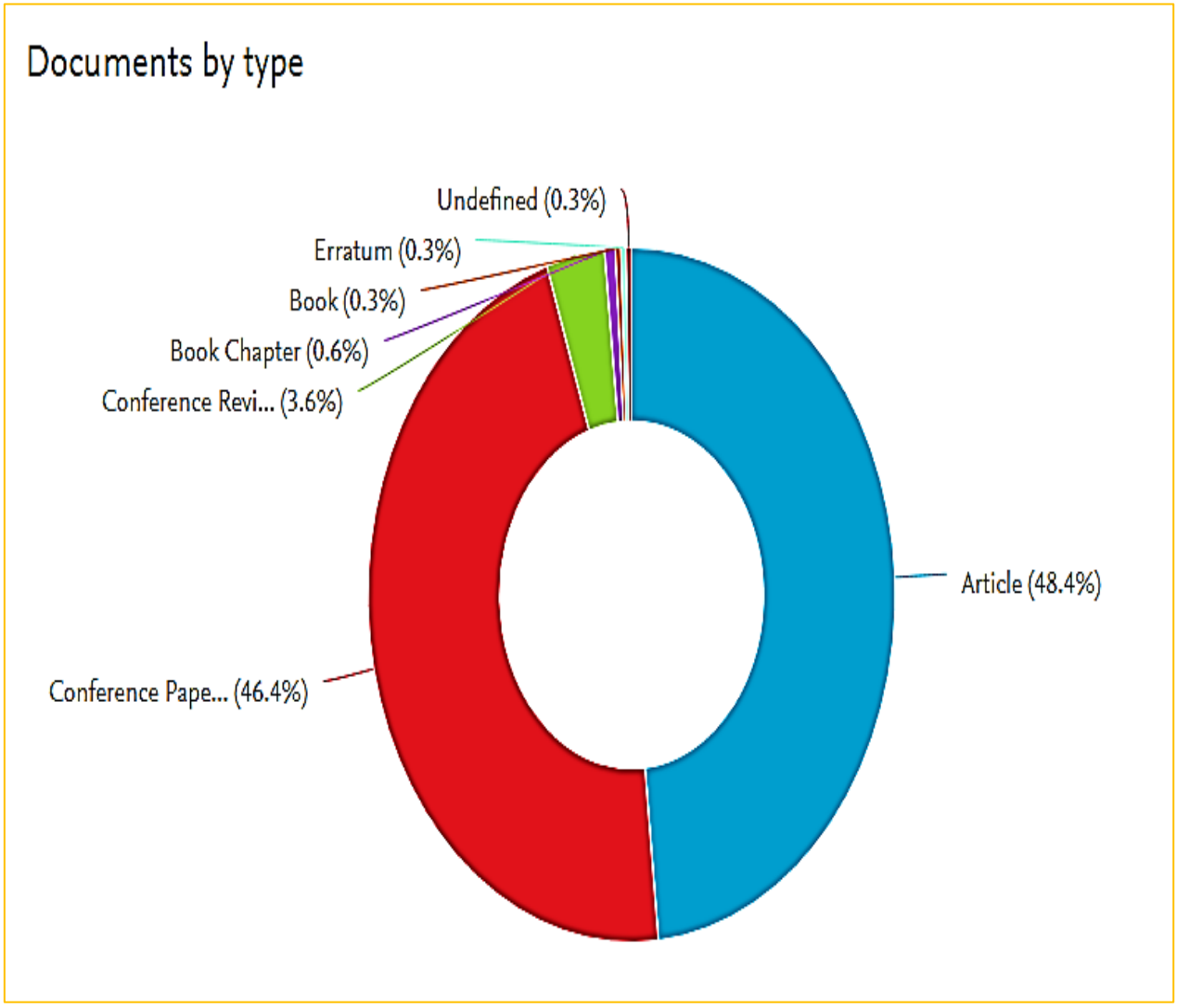

Figure 11: Various types of sources giving publication details on circularly polarized antennas

Source: http://www.scopus.com (accessed on 19th DEC 2019)

3.8 CITATION ANALYSIS OF DATABASE

Table 6 shows year wise citations available through various publications extracted from the keywords. The maximum citation count of "*wearable circularly polarized antenna for personal satellite communication and navigation*" is 61 till date. The year wise citations count of ten papers along with citations obtained by them is given in table 6.

No. of Citations → / Publication Title ↓	Year wise Count					
	2016	**2017**	**2018**	**2019**	**2020**	**Total**
Wearable circularly polarized antenna for personal satellite communication and navigation	**20**	**13**	**13**	**15**	**00**	**61**
Wide-Band Microwave Propagation Parameters Using Circular and Linear Polarized Antennas for Indoor Wireless Channels	**4**	**2**	**2**	**7**	**00**	**15**
A broadband omnidirectional circularly polarized antenna	**13**	**12**	**14**	**06**	**00**	**45**
Dual-band circularly polarized equilateral triangular-patch array antenna for mobile satellite communications	**00**	**06**	**06**	**04**	**01**	**17**
Research on circularly polarized conical-beam antennas	**02**	**02**	**05**	**02**	**00**	**11**
Printed meandering probe-fed circularly polarized patch antenna with wide bandwidth	**08**	**06**	**11**	**11**	**01**	**37**
Low-profile compact circularly-polarized antenna based on fractal metasurface and fractal resonator	**16**	**06**	**08**	**04**	**03**	**37**
Dual-circularly polarized conical-beam microstrip antenna	**00**	**10**	**05**	**07**	**00**	**22**
Axial ratio enhancement for circularly-polarized millimeter-wave phased-arrays using a sequential rotation technique	**01**	**04**	**02**	**01**	**00**	**08**
A compact microstrip fed dual polarised multiband antenna for IEEE 802.11 a/b/g/n/ac/ax applications	**00**	**03**	**10**	**08**	**01**	**22**

Table 6: Citations analysis of various publications in circularly polarized antennas

Source: http://www.scopus.com (accessed on 19th DEC 2019)

3.9 SOURCE STATISTICS

From source statistics (Figure 12) for publications on circularly polarized antennas, it is argued that maximum numbers of papers were from China Country.

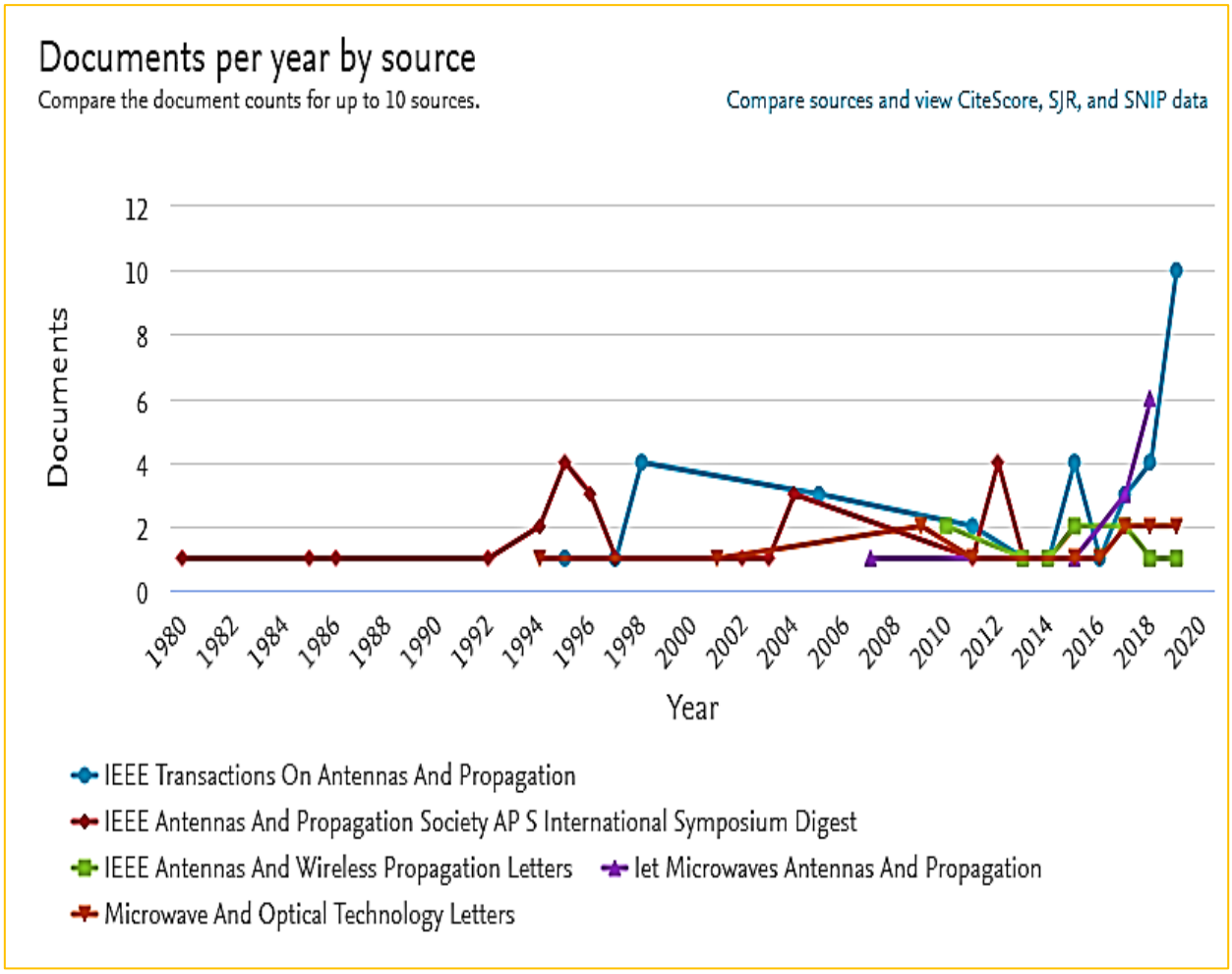

Figure 12: Source statistical analysis for papers on circularly polarized antennas
Source: http://www.scopus.com (accessed on 19th DEC 2019)

4.0 TOP FUNDING AGENCIES AVALIABLE

Figure 13 gives the top ten funding agencies available on the research area. The national natural science foundation (NNSF) is the topmost funding agency. More than 120 documents are funded by the national natural science foundation to the researchers working on circularly polarized antennas. Other funding agencies have a significant funding contribution to the research done by the antenna researchers.

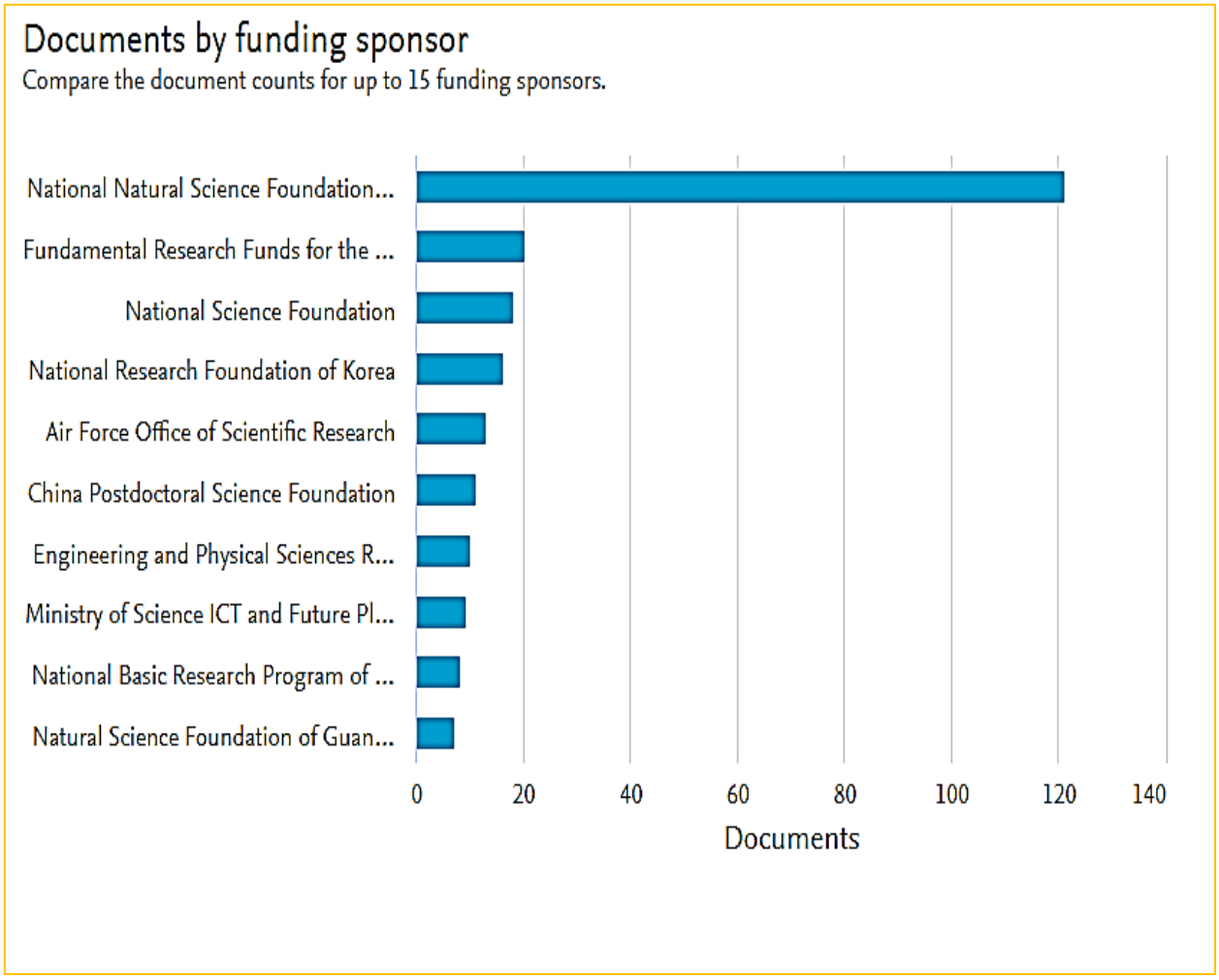

Figure 13: Top Funding sponsors on circularly polarized antennas

Source: http://www.scopus.com (accessed on 19th DEC 2019)

5 LIMITATIONS OF THE STUDY

This analysis shows that the Scopus database in combination with different keywords for various types of analysis is carried out. Some of the best publications and articles were not in the available list of Scopus database during the analysis of this data and therefore it won't be available in this analytical overview of study. This analysis is only limited to one specific language which is English

6 FUTURE SCOPE

The circularly polarized antenna is the widest possible antenna and nowadays it is used in many applications such as wireless communication, radar communication and mobile communication etc (Zhenya, Zhu and Yin, 2019), (Zhang and Liang, 2014).

The benefit of using this antenna is that it allows the signal in almost every direction as the radiation pattern of circularly polarized antenna is omnidirectional.These antennas having low gain than linearly polarized antennas so they cannot cover long distance as that of high gain linearly polarized antennas. The researchers try to improve the gain and axial ratio bandwidth in order to cover long distance by the antenna without compromising the other antenna parameters. Most of the telecommunication industries were using circularly polarized antennas for inter-BTS communication between the mobile user and tower. This is so because linearly polarized antenna cannot accepts the signal which is shifted in phase. The building and other objects causes phase disturbances to the signal and ultimately the signal is lost at the receiver in case of linearly polarized antennas. The circularly polarized antennas are more effective in this situation.

CONCLUSION

This bibliometric analysis on circularly polarized antennas was done through scopus databases. It is found that the maximum numbers of publications are from china mostly the research articles. Most of the journal papers are published by engineering people with engineering affiliations only. Chinese researchers are the topmost researcher's in these publication database followed by Japan and India. The research is to develop new technological enhancements that would reduce the cost of mobile users in many terms. The circular polarization is most useful where the linear polarization is not possible. Now, telecommunication industry wants linear and circular polarized antennas for mobile communication. The research is going on to develop such a circularly polarized antenna that gives enhanced axial ratio bandwidth and gain. So it is possible to use only circular polarized antenna for mobile communication as the linear polarized antenna having many drawbacks also. If the circular polarized antenna meets the requirement of long distance mobile communication as done by high gain linearly polarized antenna it becomes major technology and there is a remarkable reduction in number of linear polarized antennas required for mobile telecommunications. Ultimately it saves the cost of installing number of linear polarized antennas and the mobile users have to pay minimum cost to service providers available.

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