Scientometric Analysis and Visualization of Solar Eclipse Research Productivity: A Global Perspective

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Abstract

The scientometric analysis and data visualization of solar eclipse research output was based on data collected from the Web of Science database during 1992–2021. The total of 2,818 records was analyzed using various scientometric techniques such as year wise distribution, prepared area of research, most published authors and their institutions, distribution of core journals, most cited articles, and the highest contributing countries.. The research productivity on the solar eclipse has been covered in over 204 journals, with 309 papers published in the Journal of Astrophysical Sciences. The highly cited top 20 papers received a total of 13,329 citations, followed by Chemical Evolution of the Galactic Disk with 1741 citations. Also identified as the "keyword co-occurrences," the most contributing countries are America, England, Germany, France, and India.

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Keywords
ScientometricAnalysis; Solar Eclipse; Annual Growth Rate (AGR); Web of Science; VOSviever.

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Introduction

This article aims to visualize the research productivity in the solar eclipse and highlight the bibliometric dimensions. Thus, it plans to measure the number of research publications on this potential topic. The actual strength of this paper is implicit in the curious response of worldwide researchers. This research was carried out objectively to ensure research in solar eclipses and to inform researchers and scientists in this particular field. Therefore, it is considering publishing scenarios to develop the management of research in this area. Researchers can exemplify peers, policymakers can identify tactically significant research fields, and investors can make smarter decisions about their investments. Hence, it can be seen as a capacity-building tool used to improve stakeholder kindness and make better use of resources and opportunities for large-scale scientific acceptance.

Concept of Solar Eclipse

In all of the year, there are two or more solar eclipses on Earth (along with two or more lunar ones). Up until now, it has been a lifetime experience when it happens in the place, area, or country we live in. In a few days, people in Svalbard (Norway) and the Faroe Islands (Denmark) will observe a total eclipse while the rest of Europe, northern and eastern Asia, and also northern and western Africa will survey a partial occultation of the sun by the moon (the farther north the place, the bigger and longer the eclipse). The next solar eclipse visible in Europe will be in 2026. Solar eclipses happen when the Moon, in its bullet path around the Earth, happens to cross in front of the Sun. They occur only at new moon but do not happen all the month as the moon's orbital plane is tilted by 5° since the Earth orbital plane around the Sun (called the ecliptic as both lunar and solar eclipses occur when the three-substance support is in it). For a solar eclipse to occur, the fresh moon time has to occur when the moon is exactly crossing the ecliptic (during a lunar eclipse, the moon makes the cross at the full moon time).

Review of Related Literature

The fact that there is no scientometric or bibliometric study on solar eclipse research output Therefore, some of our study's relevant objective papers were selected for review of the literature. The following is a review of related literature: Over Jolvis K. R. et al. (2021) discussed the bibliometric analysis of microfluidic technology research productivity as

reflected in 745 records from the Scopus database. Out of this, there were 478 (64.16%) articles, 140 (18.8%) review papers, 95 (12.75%) conference papers, 26 (3.49%) book chapters, and 6 (0.8%) others. The first paper in food microfluidics was published in 2003. It was discovered that 72.08 percent of the documents were published in the previous six years (2015–2020). China and the United States were the two most productive countries. Purdue University had the most with 31 documents and 816 total citations. Yanbin Li is the most prolific author, with 20 research publications. The analysis verified that Biosensors, Bioelectronics, and Lab on a Chip were the most productive journals. Ishwar Dutt (2020) this study examines the top five countries that collaborated with India in nuclear and high energy physics from 1996 to 2019 using the Scopus-linked SCImago database. A total of 7,69,180 research documents were published worldwide. The top five contributing countries are the United States (16.47%), Germany (8.64%), Japan (6.65%), China (6.41%), and Russian Federation (5.89%), with India ranking 10th with 21,157 research records and 2.75% of the global share. The average normalized external citation size varies between 7.4 (United States) and 1.2 (China), while the average normalised external citation size per publication varies only between 1.9 (United States) and 1.0 (India), signifying to some extent the better performance of India. In comparison to other top countries, India performed slightly better even after investing the highest percentage of GDP (less than 1% from 1996 to 2018) in research.Sajana and M. Krishnamurthy (2017) conducted scientometric analyses on space technology using the Web of Science database from 2012 to 2016. This study analyzed growth rate, authorship pattern and collaboration, citation impact, Indian contributions, etc. A total of 7,504 papers were published during the study period, receiving a total of 40,362 citations with an average of 5.37% citations per paper.

Objectives of the Study

- To study the annual growthrateof solar eclipse research output;
- To identify the most preferred areas of research
- To identify the most prolific authors and institutions in the solar eclipse;
- To identify publishing activities and discover core journals;
- To study the citation analysis and most cited papers in the solar eclipse and
- To identify the geographical area wise distribution of documents.

Methodology

The Web of Science database was used to collect he mandatory data for this study. A total of 2,818 research publications were obtained on December 20, 2022, to meet our study's needs. The Web of Science database is also called the Web of Knowledge and was developed by Thomson Reuters. It is a multidisciplinary indexing or bibliographic database. The database was periodically updated with all the research documents. The solar eclipse research literature was the first search in the Web of Science database, after getting total records analyzed using scientometric terminals, which were used in this study. The TS for topic was used as a search strategy to find the publications on solar eclipse research output from 1992 to 2022. All records were searched for three types, as indicated in table 1. After being collected, the data were exported to MS Excel and transferred to scientometric sequences. The research focused on this article, such as annual growth rate, prolific authors core journals, most cited papers, keyword co-occurrence, country collaborations, etc. Also, they were used for the VOSviewer software's data visualization purposes.

Analysis of Data

The downloaded total of 2,818 solar eclipse research records was measured from several viewpoints in the subheadings of documents interpreted below:

Table 1: Search query

S. No.	Search Query	Result
1	TS=Solar Eclipse or Eclipse Solar or Solar or Eclipse (Indexes= All Web of Science categories. Timespan=1992-2021)	**4,47,411**
2	TS=Physics OR Astronomy OR Solar Eclipse (Indexes= All Web of Science categories. Timespan=1992-2021)	**4,87,458**
3	TS=Solar Eclipse (Indexes=All Web of Science categories. Timespan=1992-2021)	**2,818**

Annual Growth and Citations

Table 2 represents the annual growth of publications in the field of solar eclipse literature during the study period. The almost all-year increased level of publications, though some of the period decreased, shows in the list. The end value was split by the earlier year after testing the hypothesis of the starting value in the earlier year and measuring the percentage.

$$\mathbf{AGR} = \frac{\text{End Value} - \text{First Value}}{\text{First Value}} \text{X100}$$

Table: 2 Annual growth of solar eclipse literature and citations

Year	Publications	% Of 2814	Cumulative Publications	Growth Rate	Citations	Average Citations Per Paper
1992	40	1.419	40	0	7	0.175
1993	56	1.990	96	40	70	1.25
1994	52	1.845	148	-7.143	177	3.404
1995	55	1.951	203	5.769	337	6.127
1996	41	1.455	244	-25.455	394	9.610
1997	41	1.455	285	0	468	11.414
1998	42	1.490	327	2.440	468	11.143
1999	86	3.052	413	104.762	605	7.0348
2000	72	2.555	485	-16.279	683	9.486
2001	85	3.0164	570	18.0556	849	9.989
2002	64	2.271	634	-24.706	852	13.312
2003	51	1.810	685	-20.313	973	19.0784
2004	51	1.810	736	0	992	19.451
2005	58	2.059	794	13.725	995	17.155
2006	78	2.768	872	34.483	1164	14.923
2007	77	2.732	949	-1.282	1521	19.753
2008	89	3.158	1038	15.584	1756	19.730
2009	91	3.229	1129	2.247	2021	22.209
2010	110	3.903	1239	20.871	2372	21.563
2011	133	4.720	1372	20.901	3038	22.842
2012	140	4.968	1512	5.264	3123	22.308
2013	125	4.436	1637	-10.714	3181	25.448
2014	124	4.400	1761	-0.8	3582	28.887
2015	129	4.578	1890	4.032	3640	28.217
2016	142	5.038	2032	10.078	4418	31.112
2017	140	4.969	2172	-1.408	4713	33.664
2018	172	6.104	2344	22.857	5779	33.599
2019	138	4.897	2482	-19.767	5555	40.253
2020	144	5.111	2626	4.348	6376	44.278
2021	192	6.814	2818	33.333	7156	37.270
Total	**2,818**	**100**			**67,265**	

Author Keywords Co-Occurrence

The study evaluates and prepares from the Web of Science's solar eclipse research. Keywords used by the researchers in their respective papers were used to identify the main and subfields of research using the VOSviewer software and visualize the active keyword.

The study considers all authors keywords and selects a minimum number of occurrences for each keyword. Also verify the broad research field and most used authors keywords: solar eclipse with 253 occurrences and 501 total link strength, followed by ionosphere with 68 occurrences and 211 total link strength, total solar eclipse with 54 occurrences and 103 total link strength, ozone with 31

occurrences and 124 total strength, and gravity waves with 28 occurrences and 118 total link strength. The following active sub keyword occurrences of solar eclipse to increase The data visualization picture exposed some bunches of keywords in different colored bubbles.The larger bubbles, the better the strength of keywords, and it is coordinated with all keyword bubbles. The clusters in Figure 1 are different colors and sizes. Some keywords are closely associated with solar eclipse.

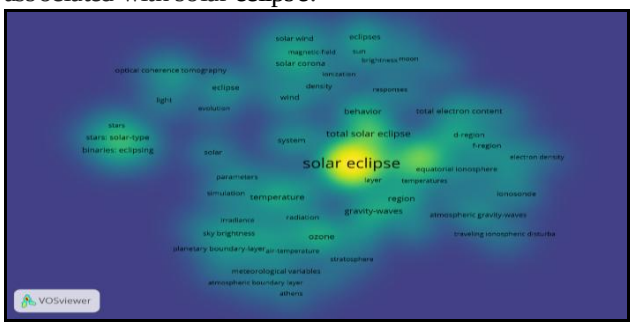


Figure 1: Author keywords co-occurrence Network map

Most prolific authors and affiliation in solar eclipse

Table 3 shows a few of the most prolific authors who have published more than 20 publications in solar eclipse research. The top 15 most productive authors contributed a total of 412 papers and 24,976 citations. Torres, G., from the Smithsonian Institution, United States of America, is found to be the most prolific author with 36 papers and 368 citations with an h index of 21, followed by Maxted, P. F. L., from Keele University, England, with 32 papers, Southworth, J., from Keele University, England, with 32 papers, and the research productivity in the different forms are: atmosphere, binary eclipse, star solar type, temperature, etc., as shown in figures 1 and 2.

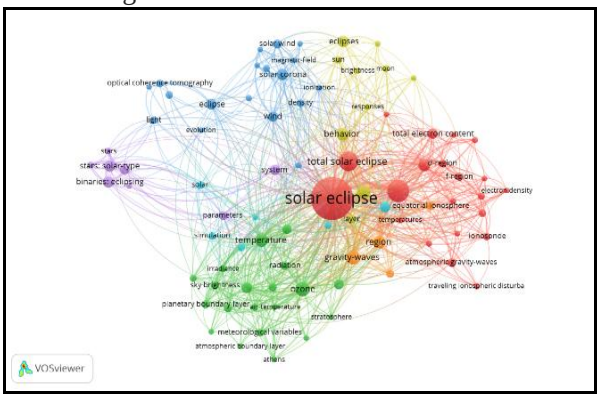


Figure 2: Author keywords co-occurrence density map

so on. Deming, Drake, and Gillon, M., were found to be the topmost authors among more than 29 papers by productive authors. The h-index was measured for the topmost authors. It calculated the number of citations from the researcher's publications. W. Latham, D., was placed at the top of the list with a sixth number of publications. Chernogor, L. F. (7), J. Fortney, Jonathan (8), Queloz, D. (9), Habbal, Shadia R. (10), Pasachoff, Jay (11), Miloslav, Druckmuller (12), Udry, Stephane (13), A. Knutson, Heather (14) and Stassun, Keivan (15) are top positions. The study found that among the leading authors, the most popular are from the USA, with the highest publications and citations.

Table 3: Most prolific authors in solar eclipse research

Author	Affiliation	NP	TC	ACP	h-index
Torres, G	Smithsonian Intitution,United States of America	36	3475	96.527	21
Maxted, P F I	KeeleUniversity,England	32	2207	68.968	19
Southworth, J	Keele University, England	32	1454	45.437	20
Deming Drake	University System of Maryland, United States of America	29	1682	58	20
Gillon, M	University of Liege, Belgium	29	2182	75.241	19
Latham, D W	Smithsonian Institution, United States of America	28	2299	82.107	18
Chernogor, L F	Ministry of Education & Science of Ukraine, Ukraine	27	338	12.518	12
Fortney, L J	University of California System, United States of America	27	3118	115.481	21
Queloz, D	University of Cambridge, England	27	2172	80.444	17
Habbal, S R	University of Hawaii System, United States of America	27	624	23.111	17
Pasachoff, Jay	Johns Hopkins University, United States of America	27	399	14.777	13
Miloslav, Druckmuller	Brno University of Technology, Czechia	25	706	28.24	17
Udry, Stephane	University of Geneva, SWITZERLAND	23	1692	73.565	17
A. Knutson, Heather	California Institute of Technology, United States of America	22	1636	74.363	20
Stassun, Keivan	Vanderbilt University, United States of America	21	992	47.238	15

Authors and co-authors Visualization

In this paper, two types of maps were visualized: a network map and a density visualization map of the same data map seen from different angles. Figure 3 shows only authors considered from the respective tables, like the most prolific authors mentioned, while figures 4 and 5 consider all authors in the solar eclipse research field during the study period.

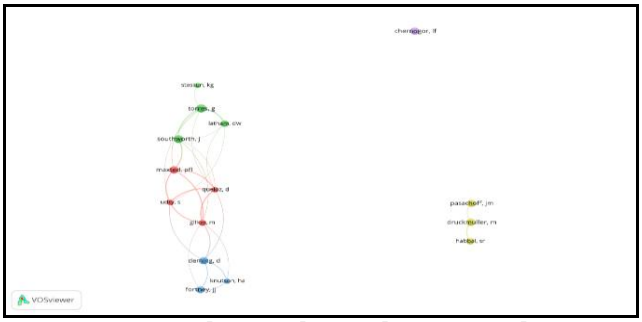


Figure 3: Authors and co-authors network map

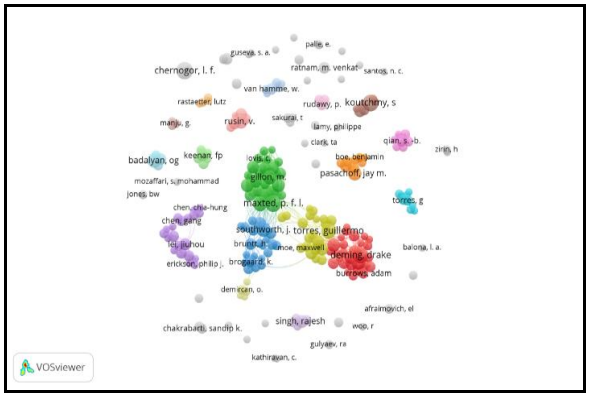


Figure 3: All Authors and co-authors network map

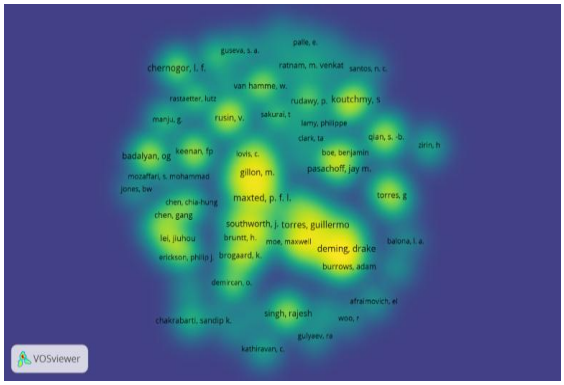


Figure 4: All Authors and co-authors density map

Distribution of core journals

Table 4 represents the source of information available in journals chosen by researchers. Out of 2,818 publications, 1,349 papers were published by the top 10 journals, with a total of 50,028 citations. The highest product journals are determined by the occurrence of related articles published in the journal. Most papers on the solar eclipse were published in the Journal of Astrophysical Journal with 309 papers, followed by the Journal of Astrophysics and Astronomy with 272 papers, Monthly Notices of The Royal Astronomical Society with 173 papers, the Astronomical Journal with 115 papers, and Solar Physics with 114 papers, and then the Journal of Geophysical Research: Space Physics with 93 papers, Advances in Space Research with 81 papers, the Journal of Atmospheric and Solar Terrestrial Physics with 76 papers, Geomagnetism and Aeronomy with 64 papers, and Geophysical Research Letters with 52 papers. Also were identified the citations per journal and the journal citations indicator ranking report.

Table 4 Distribution of top 10 journals

Name of the Journal	Publications	Citations	CPJ	JCI-2021
Astrophysical Journal	309	21625	69.983	1.05
Journal of Astrophysics and Astronomy	272	12685	46.639	0.25
Monthly Notices of The Royal Astronomical Society	173	5275	30.491	1.12
Astronomical Journal	115	3585	31.173	1.25
Solar Physics	114	1623	14.236	0.56
Journal of Geophysical Research Space Physics	93	1880	20.215	0.6
Advances in Space Research	81	682	8.419	0.7
Journal of Atmospheric and Solar Terrestrial Physics	76	1236	16.263	0.5
Geomagnetism and Aeronomy	64	367	5.739	0.21

CPJ=Citation Per Journal, JCI= Journal Citation Indicator

Top most cited papers

The highly cited top 20 papers that received a total of 13,329 citations are shown in table 5. The most highly cited paper is "The chemical evolution of the galactic disk" (TC 1741), followed by A large stellar evolution database for population synthesis studies (TC 1035) and Accurate masses and radii of normal stars: modern results and applications (TC 1023). The remaining 17 papers have fewer than 1000 citations from the list

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Table 5: Top 20 most cited papers of the solar eclipse

Title of the paper and Year	First Author	TC	TCPY
The chemical evaluation of the galactic disk.1. Analysis and Results, 1993	Edvardsson, B	1741	58.03
A large stellar evolution database for population synthesis studies, 2004	Pietrinfemi, A	1035	54.47
Accurate masses and radii of normal stars: modern results and applications, 2010	Torres, G	1023	78.69
A new non-linear limb-darkening law for lte stellar atmosphere models, 2000	Claret, A	984	42.78
Detection of an extrasolar planet atmosphere, 2002	Charbonneau, D	974	88.54
Shrinking binary and planetary orbits by kozai cycles with tidal friction, 2007	Fabrycky, D	960	60
Kepler mission design, realized photometric performance, and early science, 2010	Koch, D G	884	68
The false positive rate of kepler and the occurrence of planets, 2013	Fressin, F	769	76.9
A unified theory for the atmospheres of the hot and very hot jupiters: two classes of irradiated atmospheres, 2008	Fortney, J J	588	39.2
Mind your ps and qs: the interrelation between period (p) and mass-ratio (q) distributions of binary stars, 2017	Moe, M	531	88.5
Lewis acid-catalysed formation of two-dimensional phthalocyanine covalent organic frameworks, 2010	Spitler, E L	530	40.76
The mass-luminosity-relation for stars of mass 1.0 to 0.08m-circle-dot, 1993	Henry, T J	453	15.1
Transiting exoplanets from the corot space mission viii. Corot-7b: the first super-earth with measured radius, 2009	Leger, A	433	30.92
How to constrain your m dwarf: measuring effective temperature, bolometric luminosity, mass, and radius, 2015	Mann, A W	383	47.87
Improving parsec models for very low mass stars, 2014	Chen, Y	365	40.55
The zwicky transient facility: data processing, products, and archive, 2019	Masci, F J	362	90.5
A temperature and abundance retrieval method for exoplanet atmospheres, 2009	Madhusudhan, N	346	24.71
Spin-orbit angle measurements for six southern transiting planets new insights into the dynamical origins of hot jupiters, 2010	Triaud, Ahmj	323	24.84
Transmission spectra as diagnostics of extrasolar giant planet atmospheres, 2001	Brown, T M	323	14.68
Eclipsing binaries in open clusters - ii, 2004	Southworth, J	322	16.94
Total		**13,329**	

Top 5 Countries collaboration

The table 6 shows the major contributing countries are America, England, Germany, France, and India. When these nations are compared, America is the highest-producing country with 1072 publications; the rest of these four countries contributed almost equally with only small differences. All the countries have increased their publication of solar eclipse research year by year, and it shows Indian researchers how to compete in research with other top countries. It includes all five countries and a total of 2,282 papers published over the study period, i.e., 30 years from 1992 to 2021.

Table: 6 Top 5 Countries collaboration of solar eclipse research

Year	America	England	Germany	France	India	TP (5 Countries)
1992	18	4	4	5	1	32
1993	25	2	5	5	2	39
1994	28	4	2	5	1	40
1995	26	6	7	4	4	47
1996	14	3	4	6	3	30
1997	13	3	1	2	6	25
1998	14	4	6	3	2	29
1999	23	6	13	7	7	56
2000	21	11	6	8	1	47
2001	17	15	16	7	3	58
2002	17	14	8	4	7	50
2003	16	6	4	8	0	34
2004	19	9	2	2	3	35

2005	21	9	5	5	o	40
2006	31	11	7	8	2	59
2007	23	5	9	8	4	49
2008	32	6	6	5	3	52
2009	26	9	10	10	5	60
2010	44	18	10	12	13	97
2011	38	11	12	12	28	101
2012	48	15	13	14	24	114
2013	45	15	16	16	21	113
2014	56	21	17	18	13	125
2015	59	25	20	14	8	126
2016	42	31	17	9	8	107
2017	65	24	17	9	8	123
2018	89	30	23	18	9	169
2019	70	22	11	12	6	121
2020	64	26	18	6	14	128
2021	68	40	23	21	24	176
Total	**1072**	**405**	**312**	**263**	**230**	**2282**

Figure 5 and 6 shows the collaboration network map of countries in solar eclipse publications. Each bubble represents a country, and the sizes of these bubbles are determined by the total research productivity of the country. Out of 86 countries, 35 met the threshold with a minimum of 30 contributions each; the network map has 3 clusters. The top 5 most-contributing countries are namely: America, England, Germany, France, and India. The space between the bubbles and the thickness of the curved lines shows the level of collaboration between one country and another.

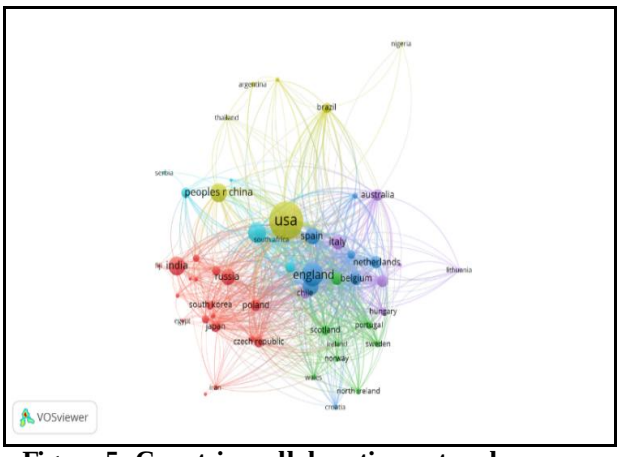


Figure 5: Countries collaboration network map

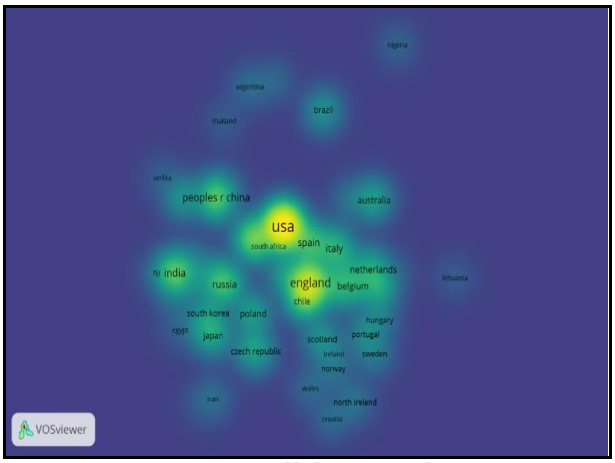


Figure 6: Countries collaboration density map

Conclusion

This study focused on the literature on solar eclipse research by scientometric measurements as considered in the Web of Science database during 1992–2021. It has experienced major growth from 2010 on, and the growth rate is 33.333% in 2021. The study discovered 253 solar eclipse keyword co-occurrences and received the highest reflected keyword. The study identified the most prolific author, i.e., Torres, G., with a total of 36 publications and good citations compared to others. And also identified the most cited papers and most productive journals. We also identified year-wise countries for collaboration. During this study, almost all papers in English were observed, with only a few papers in other languages. And most of the publications are in the form of articles in the field of solar eclipse research. This study used VOSviewer software for visualizing their respective data, and it focused on good visualizations of the network map and density map. This study helps encourage young researchers to focus on their particular fields. It is also known how Indian researchers performed on solar eclipse research.

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