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Research Article

Scientometric Portrait of India's Renowned Chemist from Indian Institute of Science: Dr. Gautam Radhakrishna Desiraju

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ABSTRACT

Introduction: The current study employs 'Bio-Bibliometrics' to analyze the scientific achievements of Dr. Gautam Radhakrishna Desiraju (GRD), a distinguished researcher and chemist, affiliated with Indian Institute of Science (IISC) one of top research institute of India. **Design/Methodology/Approach:** The data was downloaded from one of the novel data 'Scopus' indexing and abstracting databases, a product of Elsevier. **Results/Discussion:** The analysis found that most of his documents came in the form of research articles 343 (80.33%). Majority of this publication came with collaborative work with other scientists and had worked with over 1039 authors throughout his research career, which indicated a high value of collaboration coefficient (0.68) and degree of collaboration (0.93) over the years. **Conclusion:** Dr. GRD is an exceptionally talented expert in his field and has made significant contributions to the knowledge domain. He was at peak productivity between the ages of 61-70 years. "Crystal Growth and Design" (35 papers) was the most used communication channel to publish his work. The present study was intended to study the Bio-bibliometric profile of Dr. G R Desiraju one of the renowned scientists and former professor IISc, Bangalore. The data was downloaded from one of the novel data 'Scopus' indexing and abstracting databases, a product of Elsevier.

Keywords: Bio-Bibliometrics, Prof. Gautam Radhakrisha Desiraju, Chemist, India.

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INTRODUCTION

It is worth mentioning that there are various methods to assess the development of literature, such as Librarmetry (Ranganthan, 1948), Bibliometrics (Alan Pritchard, 1969), Informetrics (Otto Nacke, 1979), and Scientometrics (Braunin, 1977).

A distinguished 'Bibliometrician' Kademani hailing from India was the first to employ the term "Scientometric Portrait" in conducting a bio-bibliometric analysis of Nobel laureates and scientists in India (B. Kademani *et al*., 1996). "Bio-bibliometric studies refer to the quantitative and analytical methods used to analyze the relationships between bio-data and biblio-data elements" (Sen and Gan, 1990). The process involves the methodical examination of scholarly literature, scientific publications, and the vast amount of knowledge they contain in order to reveal concealed patterns, identify rising areas of interest, and evaluate the influence of research contributions of individuals (Kappi, *et al*., 2021). The significance of science and scientists in the advancement of a nation is paramount. Scientists endeavor to investigate the mechanisms behind the laws of nature through the application of diverse scientific methodologies. The significance of this matter extends beyond mere acquisition of knowledge, as it also enables the development of novel technologies that enhance the quality of human existence. In this context, the significance of scientists' Scientometric profile is of paramount relevance. This study employs a bio-bibliometric approach to investigate scholarly publications of Prof. Sir Gautam R Desiraju, esteemed scientist of 'Indian Institute of Science'.

Biographical sketch of Sir Gautam R. Desiraju

Gautam Radhakrishna Desiraju, popularly known as Gautam R. Desiraju was born on August 21, 1952, in Madras. Sir Desiraju completed his schooling at Cathedral and John Connon Boys School, Bombay, and later pursued his graduation in the BSC stream from St. Xavier's College, Bombay, in 1972. He obtained his Ph.D. in 1976 under the supervision of David Y. Curtin and Lain C. from the University of Illinois, Urbana-Champaign. He held numerous positions throughout his entire career and started working as a researcher (1976-1988). He worked as a researcher at

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the laboratories of Eastman Kodak Company in Rochester, New York. Further, he joined the Indian Institute of Science, Bangalore, as a research fellow (1978-1979). Later, he held different (lecture, reader, and professor) positions and spent most of his 30 years' service at the University of Hyderabad (1979-2009). Desiraju was appointed as Professor at the Indian Institute of Science, Bangalore (2009-2018) and worked as Honorary Professor at the Indian Institute of Science, Bangalore between (2018-till date).

Notable Recognition and Awards

- Alexander von Humboldt Forschungspreis, 2000.
- International Editorial Advisory Board Angewandte Chemie.
- Editorial Advisory Board Journal of the American Chemical Society.
- Editorial Advisory Board Chemical Communications.
- Former President International Union of Crystallography (IUCr) 2011-2014.
- Honorary doctorate degree, Universidad Nacional de Córdoba, Argentina, 2014.
- Honorary doctorate degree, Rayalaseema University, Kurnool, 2017.
- Honorary doctorate degree, Gulbarga University, Kalaburagi, 2022.
- Acharya P. C. Ray Medal for Science & Technology, University of Calcutta, 2015.
- ISA Medal for Science, University of Bologna, 2018.
- Van der Waals Prize, ICNI, Strasbourg, 2023.

Special issue of "Crystal Growth and Design" from the ACS was published in 2012 to honor Professor Desiraju's contributions to the area of crystal engineering.

Desiraju significant contribution significant contributions to the advancement and growth of the field of crystal engineering and top recognition came from published books on crystal engineering (Elsevier, 1989; World Scientific, 2011) and the weak hydrogen bond in structural chemistry and biology (OUP, 1999) are particularly well known. He is one of the most highly cited Indian scientists with more than 475 research papers, 65000 plus citations and an h-index of 103. His recent book "Bharat: India 2.0" is his first publishing venture outside the scientific domain and is concerned with the constitutional history of India and the re-imagination of India as a civilizational state rather than a nation-state. A second book on "India's supply chains in a changing world" is in preparation.

REVIEW OF LITERATURE

In recent years many of the studies have been conducted on 'Bio-Bibliometric' and 'Scientometric Portrait' to gauge the research outcome of renowned scientist, Nobel Laureate and well-known authors from different fields. It is important to know the unique contribution made by the authors to the knowledge domain. Some of the closed papers have been selected and reviewed for the present study.

Kademani *et al.*, 1996 conducted a study on the scientific contribution of Nobel laureate and a well-known 'Astrophysicist' S Chandrasekhar. Most of his works came from studying 'stellar structure and stellar atmospheres' and the most preferred channel for publishing articles was 'Astrophysics Journal'.

Similar study was found by Kademani *et al.*, 1999 to study the contribution of Nobel Laureate and renowned crystallographer Dorothy Crowfoot Hodgkin' in the chemistry domain. The majority of contribution came in the single authored papers where more dominant and most of her publications were found in the areas of 'general crystallography' and 'insulin'.

Manjunath & Ramesha (2015) studied the communication and collaboration pattern of Nobel laureate and notable Indian physicist Prof. C V Raman which was reflected in Google scholar. The analysis resolved that the majority of his works came in sole authored papers and two authored papers. Top communication channel was 'Proceedings of Indian Academy of Science-A' and top collaborator was Krishan K S among the fellow authors. Similar study was found by Kavitha & Chandrashekara (2020) to know the research outcome of eminent Indian academician and researcher 'Prof. K Byrappa'.

Barik & Jena (2016) examined research outcomes that were listed in the Scopus database of Prof. Amartya Sen Indian economist, Bharat Ratna and Nobel laureate. The majority of papers are found in the core areas of econometrics, finance, management, business, accounting and decision making. He used to publish the majority of publications as sole authored works and top citations were found on 'Elements of a theory of human rights' among his research papers.

Madhu & Kannappanavar (2020) studied the research outcome of former director and professor P Balaram from Indian Institute of Science, Bangalore, India. The study found that the majority of productive publications came in the form of research articles, most works came with different collaborative authors and most preferred areas of research were peptide and mass spectrometry.

Garg & Kumar (2019) analysed the 595 document which was produced by top agricultural scientist 'Dr. Hari Chand Sharma' from India. The analysis found that 45 per cent of documents came in the form of research articles. Most of his publications were published in medium impact factor journals originating from UK, USA and Netherlands countries. He has collaborated with

more than 1,000 authors with a high value of CC (Collaboration Coefficient) with 0.66.

METHODOLOGY

The present study was intended to study the bi-bibliometric profile of Dr. G R Desiraju, one of the renowned scientists and former professor at IISc, Bangalore. The data was downloaded from one of the novel data 'Scopus' indexing and abstracting databases, a product of Elsevier. The author key search was performed with a key string of (AU-ID ("Desiraju, Gautam R." 35475101700)) and complete citations were downloaded in CSV format for data analysis. All the data was tabulated using Microsoft Excel and R-studio.

OBJECTIVE OF THE STUDY

To investigate types of research documents generated by G R Desiraju from 1977-2022.

To examine frequency in the year-wise publication of articles and authorship appearance (main and co-author) in each publication.

To examine the prominent co-authors of his research contributions and collaborative research pattern of G R Desiraju.

To investigate peak productive period and publications outcome in relation to his age.

To analyse the most preferred communications channel used for publications.

To analyze the most opt keywords and top-cited publications among his publications.

Data Analysis and Interpretation

Publications Output

During his prolonged academic and research career, Dr. Gautam R. Desiraju, in total, published 427 different forms of documents in structural chemistry, and its sub-disciplines are listed in Table 1. The majority of publications came in the form of 343 (80.33%) research articles in various reputed journals that were published in different parts of the world. Only the research papers constituted more than two-thirds of the published documents. Followed by review papers 25 (5.85%), editorial content 20 (4.68%), letters 15 (3.51%), conference papers 9 (2.11%), short notes 6 (1.41%), short surveys 4 (0.94%), book chapters 4 (0.47%), erratum 2 (0.47%), and book 1 (0.23%). Similar to other scientists included in the publication, Dr. Gautam R. Desiraju has also published the greatest number of academic articles. The subsequent paragraphs provide a comprehensive analysis of the many facets of the study, which is based on 343 papers published as journal articles.

Annual Productive Life and Authorship Appearance

A complete statistical analysis performed with help of bibliometric indicators to know the annual productivity and authorship appearance of Gautam R. Desiraju in Table 2. It was found from the analysis that Desiraju over the span of 45 years of his research and academic career he has published a total of 343 articles. He published 25 (7.29%) papers between 1983-1984, 1989-1992, 1994, 1996-1997, 2000-2004, 2008, and 2011 respectively. Rest of the 318 (92.71%) papers came with collaborative contributions. Its main author GR Desiraju appeared in 58 (16.91) papers and in 285 (83.09%) papers he came in different authorship positions. In multi-authored papers he appeared has 1st author in 33 (9.62%) papers, 2nd author in 89 (25.95%) papers, 3rd author in 58 (16.91) papers, 4th author in 71(20.70) papers, 5th author in 36 (10.50) papers, 6th author in 18 (5.25) papers, 7th author in 6 (1.75) papers, 8th in author 3 (0.87) papers, 9th in author 1(0.29) paper, 10th in author 2(0.58) papers and 12th in author 1(0.29) paper.

Collaboration Coefficient

The Collaboration Coefficient (CC) Ajiferuke *et al.*, 1988 proposed a singular metric for quantifying collaborative research, which they referred to as the collaboration coefficient. The approach relies on fractional productivity, as determined by Price & Beaver (1966). The formula utilized to compute CC is elucidated as follows:

$$\text{The formula for Collaboration Co-efficient CC} = 1 - \frac{\sum_{j-1}^{K}\left(\frac{1}{j}\right) fj}{N}$$

Fj is the number of j author papers.

N is the total number of research papers published.

K is the greatest number of authors per paper.

Therefore, the collaboration co-efficient of Sir Gautam R. Desiraju is 0.68.

Productivity Life Cycle

The productive age of GRD started in 1977, at the chronological age of 20 years. GRD produced the highest number of research publications (19) in 2006 and 15 research publications in 1998,

Table 1: Summary of Overall Documents Published by GRD.

Document Type	No. of Articles	Percentage
Article	343	80.33
Review	25	5.85
Editorial	20	4.68
Letter	15	3.51
Conference Paper	9	2.11
Note	6	1.41
Short Survey	4	0.94
Book Chapter	2	0.47
Erratum	2	0.47
Book	1	0.23
Total	427	100.00

Table 2: Annual Productivity of GRD. Authorship Appearance by Line-Wise Position.

Year	SA	AP-1	AP-2	AP-3	AP-4	AP-5	AP-6	AP -7	AP -8	AP -9	AP -10	AP -12	MAT	CAT	Total	CT	CA	PPA
1977	-	2	-	-	-	-	-	-	-	-	-	-	2	0	2	2	25	1
1978	-	1	-	-	-	-	-	-	-	-	-	-	1	0	1	3	26	2
1980	-	-	-	1	-	-	-	-	-	-	-	-	0	1	1	4	28	3
1981	-	1	-	-	-	-	-	-	-	-	-	-	1	0	1	5	29	4
1982	-	1	-	-	-	-	-	-	-	-	-	-	1	0	1	6	30	5
1983	1	1	-	-	1	-	-	-	-	-	-	-	2	1	3	9	31	6
1984	2	1	3	-	-	-	-	-	-	-	-	-	3	3	6	15	32	7
1985	-	-	3	-	-	-	-	-	-	-	-	-	0	3	3	18	33	8
1986	-	3	4	-	-	-	-	-	-	-	-	-	3	4	7	25	34	9
1987	-	1	5	-	-	-	-	-	-	-	-	-	1	5	6	31	35	10
1988	-	1	1	-	-	-	-	-	-	-	-	-	1	1	2	33	36	11
1989	1	7	-	1	-	-	-	-	-	-	-	-	8	1	9	42	37	12
1990	1	1	-	-	-	-	-	-	-	-	-	-	2	0	2	44	38	13
1991	2	3	-	1	-	-	-	-	-	-	-	-	5	1	6	50	39	14
1992	1	-	1	1	1	-	-	-	-	-	-	-	1	3	4	54	40	15
1993	-	1	2	-	5	-	-	1	-	-	-	-	1	8	9	63	41	16
1994	1	-	1	1	1	2	2	-	-	-	-	-	1	7	8	71	42	17
1995	-	-	-	1	1	3	-	-	-	-	-	-	0	5	5	76	43	18
1996	2	-	3	2	2	3	1	-	-	-	-	-	2	11	13	89	44	19
1997	3	-	-	2	1	4	-	2	-	-	-	-	3	9	12	101	45	20
1998	-	-	3	1	5	1	3	1	-	-	1	-	0	15	15	116	46	21
1999	-	-	1	1	2	4	2	1	-	-	-	-	0	11	11	127	47	22
2000	2	2	3	1	2	2	1	-	2	-	-	-	4	11	15	142	48	23
2001	1	1	2	1	9	1	-	-	-	-	-	-	2	13	15	157	49	24
2002	2	1	5	-	2	1	-	-	-	-	-	-	3	8	11	168	50	25
2003	1	-	2	2	5	-	2	-	1	-	-	-	1	12	13	181	51	26
2004	1	-	5	2	1	2	-	-	-	1	-	-	1	11	12	193	52	27
2005	1	-	1	2	4	3	1	-	-	-	-	-	1	11	12	205	53	28
2006	-	1	6	5	5	1	1	-	-	-	-	-	1	18	19	224	54	29
2007	-	-	7	4	-	-	-	-	-	-	-	-	0	11	11	235	55	30
2008	1	-	3	-	-	-	-	-	-	-	-	-	1	3	4	239	56	31
2009	-	1	-	1	3	2	-	-	-	-	-	1	1	7	8	247	57	32
2010	-	2	2	2	3	2	-	-	-	-	-	-	2	9	11	258	58	33
2011	2	-	4	3	3	2	2	-	-	-	1	-	2	15	17	275	59	34
2012	-	-	2	2	2	-	1	-	-	-	-	-	0	7	7	282	60	35
2013	-	1	1	2	2	1	-	-	-	-	-	-	1	6	7	289	61	36
2014	-	-	5	5	3	-	-	-	-	-	-	-	0	13	13	302	62	37
2015	-	-	2	4	4	1	2	-	-	-	-	-	0	13	13	315	63	38
2016	-	-	1	3	2	-	-	-	-	-	-	-	0	6	6	321	64	39
2017	-	-	4	1	-	-	-	1	-	-	-	-	0	6	6	327	65	40
2018	-	-	4	2	1	-	-	-	-	-	-	-	0	7	7	334	66	41
2019	-	-	1	2	-	-	-	-	-	-	-	-	0	3	3	337	67	42
2020	-	-	-	1	-	-	-	-	-	-	-	-	0	1	1	338	68	43
2021	-	-	1	1	1	-	-	-	-	-	-	-	0	3	3	341	69	44

Year	SA	AP-1	AP-2	AP-3	AP-4	AP-5	AP-6	AP -7	AP -8	AP -9	AP -10	AP -12	MAT	CAT	Total	CT	CA	PPA
2022	-	-	1	-	-	1	-	-	-	-	-	-	0	2	2	343	70	45
Total	25	33	89	58	71	36	18	6	3	1	2	1	58	285	343	-	-	-
%	7.29	9.62	25.95	16.91	20.70	10.50	5.25	1.75	0.87	0.29	0.58	0.29	16.91	83.09	100.00	-	-	-
CP	7.29	16.91	42.86	59.77	80.47	90.96	96.21	97.96	98.83	99.13	99.71	100.00	-	-	-	-	-	-

SA=Single Author; P=Position; MAT=Main Author Total; CAT=Co-Author Total; CT=Cumulative Total; CA=Chronological Age; PPA=Publication Productive Age; CP=Cumulative Percentage.

Table 3: Quinquennial Publications Productivity Years.

Quinquennium Years	SA	MA	Total	DC	CA	PPA
1977-1982	-	6	6	1.00	25-30	1-5
1983-1987	3	22	25	0.88	31-35	6-10
1988-1992	5	18	23	0.78	36-40	11-15
1993-1997	6	41	47	0.87	41-45	16-20
1998-2002	5	62	67	0.93	46-50	21-25
2003-2007	3	64	67	0.96	51-55	26-30
2008-2012	3	44	47	0.94	56-60	31-35
2013-2017	-	45	45	1.00	61-65	36-40
2018-2022	-	16	16	1.00	66-70	41-45
Total	25	318	343	0.93	-	-

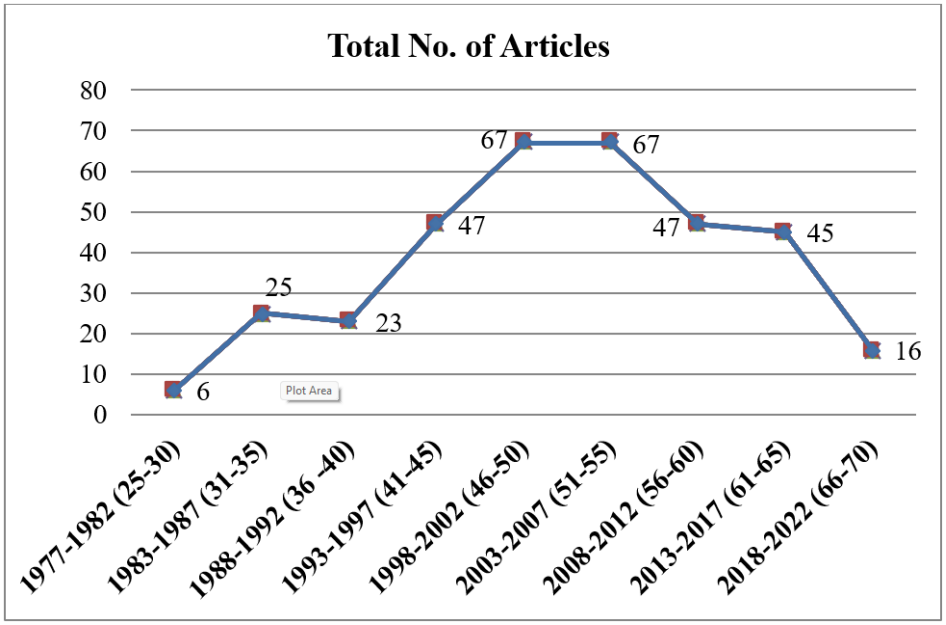

Figure 1: Annual Production trend

2000, and 2001. His productivity age was 46, 48, and 49 years, and his chronological age was 21, 23, and 24 years, respectively. It is evident that his constructive passion persisted even after his retirement. Till 2022, at the age of 70, he contributed two publications, and his chronological age was 45.

The formula for Productive Co-efficient $P_c = \frac{Chronological\ Age\ of\ Last\ Publication}{Chronological\ Age\ of\ fifty\ Percentage}$

Therefore, the productive co-efficient of Sir Gautam R. Desiraju is 1.0:1.6.

Annual Contributions

GRD's average yearly contribution during the productive age has been computed using the following formula:

Table 4: Top Ten Collaborations.

Top Ten Collaborative Authors and No. of Publications				
Nangia, A. (30)	Bose, R. (28)	Howard, J.A.K. (27)	Sarma, J.A.R.P. (27)	Thakur, T.S. (23)
Jetti, R.K.R. (19)	Thalladi, V.R. (16)	Allen, F.H. (15)	Banerjee, R. (13)	Bläser, D. (13)

Table 5: Top Ten Preferred Journals.

Sl. No.	Title of the Journal	No. of Papers	CT	FPY-LPY
1	Crystal Growth and Design	34	34	2001-2022
2	Chemical Communications	32	66	1983-2018
3	Journal of The American Chemical Society.	25	91	1977-2018
4	Journal of The Chemical Society Chemical Communications.	24	115	1983-1995
5	Crystengcomm	23	138	2002-2021
6	Acta Crystallographica Section C Crystal Structure Communications.	17	155	1996-2011
7	Angewandte Chemie International Edition.	14	169	2003-2022
8	Acta Crystallographica Section B Structural Science.	11	180	2006-2011
9	Journal of the Chemical Society Perkin Transactions 2.	11	191	1983-1999
10	Acta Crystallographica Section E Structure Reports Online.	10	201	2004-2012
11	IUCRJ	9	210	2014-2021
12	Accounts of Chemical Research	7	217	1986-2019
13	Chemical Physics Letters	6	223	1980-1987
14	20 periodical came out with 5 papers each.	20	243	1984-2020
15	32 periodical came out with 4 papers each.	32	275	1984-2019
16	5 periodical came out with 3 papers each.	15	290	1977-2017
17	10 periodical came out with 2 papers each.	20	310	1982-2015
18	33 periodical came out with 1 paper each.	33	343	2011-2015

Table 6: Top Author Keywords.

Top Author Keywords and No of Publications				
Crystal Structure (95)	Hydrogen Bond (63)	Crystallization (45)	Crystal Engineering (41)	Hydrogen Bonds (40)
Chemical Structure (34)	Unclassified Drug (32)	Supramolecular Chemistry (28)	Chemistry (26)	Hydrogen (22)

The formula for Annual Contribution

$$\text{Ayc} = \frac{Total\ Contribution}{Total\ Productive\ Age}$$

The average annual contribution of Sir Gautam R. Desiraju is 7.62, and on average, he has published 7-8 papers annually between 1977 and 2022.

Collaboration Rate

The Collaboration Rate (CR) is calculated by dividing the number of publications with multiple authors published over a quinquennium period by the total number of papers published during the same period. According to this ratio, it has been noted in Table 3 that the CR value for the full period from 1977-2022 was 0.93 and one between 1977-1982, 2013-2017, and 2018-2022. It occurred near to one during the quinquennium of 1998-2002, 2003-2007, and 2008-2012. It was evident from the analysis that Dr. Gautam R Desiraju has given preference for teamwork over individual work over the years. Out of all his published papers, only 25 (7.29%) were authored solely by him, while the remaining were all multi-authored articles.

The formula for Degree of Collaboration $DC = 1 - \frac{f1}{N}$

F_1=is the number of single author papers.

N=total number of papers published in a single year.

Therefore, the Degree of Collaboration of Sir Gautam R. Desiraju is 0.93.

Top Collaborative

Collaboration among authors brings different ideas together, creating new areas of productive work. In total, Gautam R. Desiraju worked with 160 authors, and Table 4 discusses the top 10 collaborators. The top productive authors with Gautam R. Desiraju were Nangia A (30), Bose R (28 papers), Howard J.A.K. and Sarma J.A.R.P. (27 papers), Thakur T.S. (23 papers), Jetti, R.K.R. (19 papers), Thalladi V.R. (16 papers), Allen F.H. (15 papers), Banerjee R. and Blaser D. (13 papers).

Top Communication Channels

General publishing of manuscripts in reputed journals is one of the decision criteria in the higher education sector. The majority of authors prefer to publish their manuscripts in highly influential journals relevant to their research area. Dr. Gautam R. Desiraju published 343 research articles that were scattered across different journal publications. Most of his articles were published in "Crystal Growth and Design" (34 papers) between 2001 and 2022, followed by Chemical Communications (32 papers) between 1983 and 2018, the Journal of the American Chemical Society (25 papers) between 1977 and 2018, and the rest are listed in Table 5.

Top Ten Author Keywords

Top author keywords are important aspects where we can find trending areas of research in a particular domain. Table 6 depicts that Gautam R. Desiraju used the most keywords in his research, where Crystal Structure was used 95 times, followed by Hydrogen Bond (63), Crystallization (45), Crystal Engineering (41), Hydrogen Bonds (40), Chemical Structure (34), Unclassified Drug (32), Supramolecular Chemistry (28), Chemistry (26) and Hydrogen (22).

CONCLUSION

GRD is an exceptionally talented expert in his field and has made significant contributions to the knowledge domain. He is one of the most highly cited Indian scientists, with more than 475 research papers, 65,000 plus citations, and an h-index of 103. His recent book "Bharat: India 2.0" is his first publishing venture outside the scientific domain, and his second book, "India's Supply Chains in a Changing World," is in preparation. He acknowledged numerous awards throughout his life span and guided many students in their research career. An examination of 343 research publications by GRD between 1977 and 2022 reveals that he contributed only 25 papers sole and the rest of the publications were combined with multiple (1039) authors. This is further supported by the high value of the collaborative coefficient, which stands at 0.63, as well as the collaboration rate was 0.93, and he has been most prolific in the past nine years.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

SA: Single Author; **P:** Position; **MAT:** main Author Total; **CAT:** Co-Author Total; **PPA:** Publication Productive Age; **CP:** Cumulative Percentage; **CA:** Chronological Age.

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