Annals of Library and Information Studies
Vol. 64, December 2017, pp. 217-228

Biobibliometric portrait of the astronomer Jan Hendrik Oort

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Received: 23 August 2016; revised: 14 November 2017; accepted: 15 November 2017

Jan Hendrik Oort is recognized as one of the greatest astronomers of the 20th century. His 225 publications that appeared during 1922-1992 are analyzed. Most of the papers of the scientist (N= 170) are non-collaborative. Oort's first paper was published in 1922 at the age of 23. The period 1957-1961, when Oort was 58-62 years old, was his most productive period (nearly 5 papers per year). From the period of 7th to 13th quinquennium (age 53-87) he produced nearly 4 to 5 papers per year. In the byline of authors his status ranged from first to third and ninth. Oort's research team comprised of 67 collaborators. C. A. Muller and G.W. Rougoor were his leading collaborators. Most of his papers were published in journals, mostly emanating from Netherlands (N=71), *USA* (N=55) and UK (27) etc. The publication concentration is 2.27 and publication density 16.16. The most frequent keywords are Galaxy(ies) (N=23), Galactic System (N=17) and Structure (N=17). Finally, it is seen that the data set does not follow Bradford law.

Keywords: Biobibliometrics; Scientometrics; J H Oort; Astronomer; Scientist; Astronomy; Astrophysics; *Radio astronomy*; G*alaxy;* Galactic system; *Milky Way*

Introduction

There are a number of biobibliometric studies field of literature, film, and science (both pure and applied)[1-42]. This biobibliometric study is on Jan Hendrick Oort, the renowned astronomer.

Copernicus, Galileo and Kepler played an important role in the discovery of our place in our own galaxy[43]. Oort was the spirit of modern astrophysics more than anyone in the last century[44] and generally regarded as one of the leading astronomers of the twentieth century. He performed most notable research works on the structure and dynamics of the galactic system. Oort also played a crucial part in the development of radio astronomy[45].

J H Oort was born on April 28, 1900 at Franeker Friesland in Netherlands. His parents were Abraham Hendrikus Oort, a physician and Ruth Hannah Faber. Oort attended primary school in Oegstgeest and H.B.S (secondary school) in Leiden. He was an indifferent language scholar and had strong interests in physics and mathematics. In 1917 he matriculated, and studied physics at Groningen University. He took the usual courses in hydrodynamics, light and sound, analysis, electricity, the method of least squares and quantum theory.

Oort had great desire to study astronomy during his high-school level. He studied popular astronomy with Jacobus Cornelius Kapteyn, Dutch Professor at Groningen University. Oort began research work with Kapteyn early in his third year.

After completing his doctoral examination in 1921, Oort was appointed assistant at Groningen. In September 1922, he went to the United States for graduation at Yale and to serve as an assistant at the Yale National Observatory. In 1924, Oort returned to the Netherlands to work at Leiden University. Here he served as a research assistant and he worked as Conservator in 1926, lecturer in 1930, and professor extraordinary in 1935. In 1926, he received his doctorate from Groningen for the thesis on the properties of high-velocity stars. Discoveries by Oort

about the Milky Way brought him much recognition. In the early 1930s, he received job offers from Harvard and Columbia Universities but chose to stay at Leiden. He spent half of 1932 at the Perkins Observatory, in Delaware, Ohio. In 1934, Oort worked as assistant to the director of Leiden Observatory; the next year he became General Secretary of the International Astronomical Union (IAU) up to 1948. In 1937 he was elected to the Royal Academy. In 1939, he spent half a year in the U.S. and became interested in the Crab Nebula[37,46 -48]

Oort's research and discoveries

Oort had shaken the scientific world by demonstrating the Milky Way rotation and he revolutionized astronomy through his ground-breaking discoveries. He pioneered many studies in the field of radio astronomy and also is a comet pioneer who received many awards[46-47].

The following models [44, 46-49] have been named after him:

- Asteroid1691 Oort
- Oort Cloud (or Hills cloud)
- Dark Matter
- Oort constants

This study covers 225 publications of Oort published in several communication channels during 1922-1992.

Objectives of the study

- To examine the distribution of publications;
- To study the authorship pattern and degree of collaboration;
- To find the time span of authorship;
- To analyze the position of Oort in the byline of authors; and
- To test Bradford's law for publications in journals

Methodology

The list of Oort's publications was collected from the database of SAO/NASA Astrophysics Data System (ADS or shortly known as ADS Database). The relevant data were analyzed using MS-Excel. For authorship count full credit was given to each author regardless of his position as the main author or co-author. Other important information regarding him has been taken from the Wikipedia and different sources on the Net[37, 46, 47].

Analysis

Distribution of papers

Table 1 shows the distribution of Oort's papers. Oort is the first author in 27 papers, second author in 22 papers, third author in 5, and ninth author in one paper. It is interesting to note that he has produced maximum number of papers (N=170) as single author. Oort's first paper appeared when he was 23 years old and total productive life spanned 71 years. His output peaked twice in 1962 and 1982 when he was at the age of 69 and 83 respectively. It is also observed that the scientist published more than half of his papers (N=116) when he was 63 years. He produced 132 papers in his retired life; two papers were published in 1992, the year he died.

Most of his collaborations were during 1924-27, 1939-1942, 1948, 1951-61, 1967-82. During 1925 and 1948 all his papers were collaborative papers and hence, collaboration coefficient is one followed by 0.75 in 1973; 0.67 in 1942 and 1957; 0.60 in 1959; 57 in 1960; 0.50 in 1963 and 1967 etc. The 50 percentile productivity life was 41 while chronological age 63. The entire active productive life of the scientist spans 71 years. The overall productivity coefficient is 0.25 (Table 1)

Author productivity

Table 2 and Fig. 1 provide the quinquennium-wise productivity of Oort. His productivity was 2-5 papers throughout the quinquenniums. He produced five papers during 1957-1961 and 1972-1976; four during 1952-1956, 1962-1966, 1967-1971 and 1982-1986; three during 1977-81, and so on. It peaked during 1957-61 touching 27(12%) and thereafter it has been up and down. His highest productivity per year is 5.4 during 1957-61, followed by 5.0 (1972-76), 4.8 (1962-1966 & 1982-1986), 4.0 (1952-1956&1967-71) and 3.8 (1977-1981).

Authorship pattern

Table 3 shows that Oort did not collaborate with anyone for most of his papers. (N=170). The remaining 55 papers are collaborative papers of which 38 are two-authored, 14 three-authored, 1 each with

Table 1—Publication productivity of Oort

Year	Authorship position as					MA	CA	TP	QTP	DC= MAP/TP	Age [1900]	PPA
	Single author	1st author	2nd author	3rd author	9th author							
1922	1					1		1	1	0.00	23	1
1924	4	1				5		5	6	0.20	25	3
1925		1	2			1	2	3	9	1.00	26	4
1926	2					2		2	11	0.00	27	5
1927	5	1				6		6	17	0.17	28	6
1928	3					3		3	20	0.00	29	7
1929	1					1		1	21	0.00	30	8
1930	3					3		3	24	0.00	31	9
1931	1					1		1	25	0.00	32	10
1932	2					2		2	27	0.00	33	11
1935	1					1		1	28	0.00	36	14
1936	1					1		1	29	0.00	37	15
1937	1					1		1	30	0.00	38	16
1938	2					2		2	32	0.00	39	17
1939	1		1			1	1	2	34	0.50	40	18
1940	1					1		1	35	0.00	41	19
1941	1	1				2		2	37	0.50	42	20
1942	2	3	1			5	1	6	43	0.67	43	21
1943	3					3		3	46	0.00	44	22
1946	2	1				3		3	49	0.33	47	25
1947	1					1		1	50	0.00	48	26
1948		1				1		1	51	1.00	49	27
1949	1					1		1	52	0.00	50	28
1950	1					1		1	53	0.00	51	29
1951	1	1	3			2	3	5	58	0.80	52	30
1952	4	1				5		5	63	0.20	53	31
1953	1					1		1	64	0.00	54	32
1954	2		1	1		2	2	4	68	0.50	55	33
1955	4	1				5		5	73	0.20	56	34
1956	4	1				5		5	78	0.20	57	35
1957	1	1		1		2	1	3	81	0.67	58	36
1958	5	2				7		7	88	0.29	59	37
1959	2	2	1			4	1	5	93	0.60	60	38
1960	3	3	1			6	1	7	100	0.57	61	39
1961	4	1				5		5	105	0.20	62	40
1962	11					11		11	116	0.00	63	41
1963	1		1			1	1	2	118	0.50	64	42
1964	4					4		4	122	0.00	65	43
1965	5					5		5	127	0.00	66	44
1966	2					2		2	129	0.00	67	45
1967	1		1			1	1	2	131	0.50	68	46
1968	2		1			3		3	134	0.33	69	47
1969	2					2		2	136	0.00	70	48
1970	6	1				7		7	143	0.14	71	49
1971	5				1	5	1	6	149	0.17	72	50
1972	2		1			3		3	152	0.33	73	51

Contd—

Table 1—Publication productivity of Oort

—Contd

Year	Authorship position as					MA	CA	TP	QTP	DC= MAP/TP	Age [1900]	PPA
	Single author	1st author	2nd author	3rd author	9th author							
1973	1	1	2			2	2	4	156	0.75	74	52
1974	5					5		5	161	0.00	75	53
1975	4	1	3	1		5	4	9	170	0.56	76	54
1976	4					4		4	174	0.00	77	55
1977	3		1			3	1	4	178	0.25	78	56
1978	3	1				4		4	182	0.25	79	57
1979	3			1		3	1	4	186	0.25	80	58
1980	1			1		1	1	2	188	0.50	81	59
1981	3	1	1			4	1	5	193	0.40	82	60
1982	9		1			9	1	10	203	0.10	83	61
1983	3					3		3	206	0.00	84	62
1984	6					6		6	212	0.00	85	63
1985	3					3		3	215	0.00	86	64
1986	2					2		2	217	0.00	87	65
1988	3					3		3	220	0.00	89	67
1989	2					2		2	222	0.00	90	68
1990	1					1		1	223	0.00	91	69
1992	2					2		2	225	0.00	93	71
Total	170	27	22	5	1	199	26	225		0.25		
%	75.56	12.00	9.78	2.22	0.44							
CP	75.56	87.56	97.34	99.56	100							

CT=Cumulative total. DC = Degree of collaboration. PPA = Publication productivity age. MA=Main author
MAP = Multiple authorship papers. TP = Total number of papers. Auth.= author, CA= Co-author

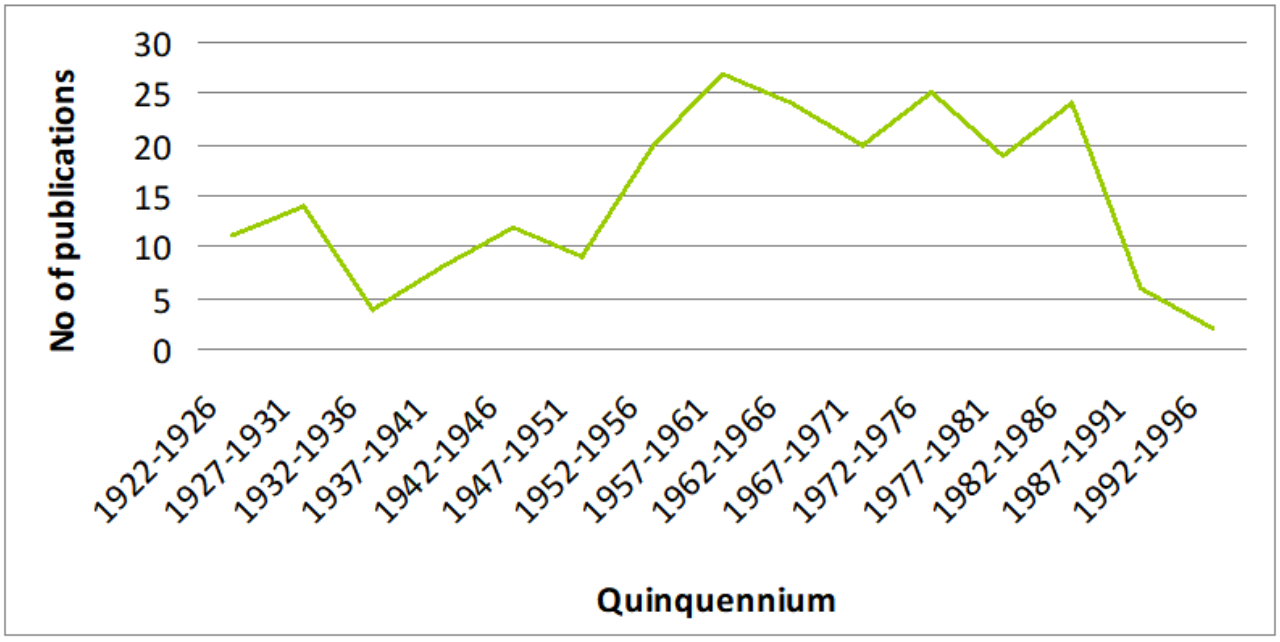

Fig. 1—Oort's productivity

Table 2—Oort's productivity

Quinquennium	Age (Yrs) [DOB 1900]	No. of Publications	Productivity per year	Percentage
1922-1926	23-27	11	2.2	4.89
1927-1931	28-32	14	2.8	6.22
1932-1936	33-37	04	0.8	1.78
1937-1941	38-42	08	1.6	3.55
1942-1946	43-47	12	2.4	5.33
1947-1951	48-52	09	1.8	4.00
1952-1956	53-57	20	4.0	8.89
1957-1961	58-62	27	5.4	12.00
1962-1966	63-67	24	4.8	10.67
1967-1971	68-72	20	4.0	8.89
1972-1976	73-77	25	5.0	11.11
1977-1981	78-82	19	3.8	8.44
1982-1986	93-87	24	4.8	10.67
1987-1991	88-92	06	1.6	2.67
1992-[1996]	93-[96]	02	0.4	0.89
Total (71 years)		225	3.2	100

Table 3—Authorship pattern

Authorship Paper Type	Single	Two	Three	Four	Five	Nine	Total
Non-collaborative	170						170
Collaborative		38	14	01	01	01	55

Table 4—Position of Oort in the byline of authors

Publications	Positions				Total	Authorship production
	First	Second	Third	Ninth		
Two-authored	23	15	-	-	38	76
Three-authored	03	06	05	-	14	42
Four-authored	-	02	-	-	01	04
Five-authored	01	-	-	-	01	05
Mega-authored (15^{th})	-	-	-	01	01	15
Total	27	23	05	01	55	142

four, five and nine authors. There is also one paper that is mega-authored (i.e. 15 authored).

Rank in the byline of authors

Oort appeared as the first author in 27 papers (Table 4). He was the second author in as many as 23 papers, third author in 05 papers, and ninth author in one paper. He produced 142 authors throughout his productive career.

Research group

Table 5 depicts that the scientist has worked with 67 collaborators in his productive career and generated the highest number of papers i.e, 5 each in collaboration with C A Miller and G W Rougoor, during the period 1951-60. Other two closed collaborators are H C van de Hulst and T Walraven, who have produced 3 papers each. Nine collaborators have produced two papers each and fifty four collaborators have one paper each.

Journals

Table 6 shows that most of his papers are in journals. *Bulletin of the Astronomical Institutes of the Netherlands* was Oort's preferred journal where he published 44 (19.56%) papers from the beginning of his career (1922) till 1968. *Astronomy & Astrophysics* (Sweden) was his next favourite journal where he

Table 5—J. H. Oort and his collaborators

Sl. no.	Author	Position in byline of author																MA	CA	TP	Period	
		Single	Two		Three			Four				Five					Mega					
			I	II	I	II	III	I	II	III	IV	I	II	III	IV	V					FYP	LYP
1	Oort, J.H.	170	23	15	3	6	5		1			1					1	197	28	225	1922	1992
2	Muller, C. A		2	1	1	1												3	2	5	1951	1982
3	Rougoor, G. W.		2	2		1												2	3	5	1957	1960
4	van der Kruit, P. C.				2													2		2	1972	1973
5	Walraven, T.			3															3	3	1956	1958
6	Hulsbosch, A. N. M.		1	1														1	1	2	1973	1978
7	Marsh, Hannah M.			2															2	2	1924	1727
8	Mathewson, D. S.						2												2	2	1972	1972
9	Pels, G.				2													2		2	1975	1975
10	van Tulder, J. J. M			2															2	2	1942	1942
11	van de Hulst, H. C.			1	1													1	1	2	1946	1954
12	van Herk, G.			2															2	2	1959	1960
13	Westerhout, G.		1				1											1	1	2	1951	1958
14	Pels-Kluyver, H. A.						2												2	2	1975	1975
15-68	54 authors having one paper each		9	9	5	6	4	1		1	1		1	1	1	1	14	16	38	54	1924	1981
	Total	170	38	38	14	14	14	1	1	1	1	1	1	1	1	1	15	225	88	314		

Table 6—Channel-wise publications

Sl. no.	Communication channels	Country	Paper	%	CMT %	FYP	LYP
Group: A	**Journal & Periodicals (J & p) [64.99%]**						
1	*Bulletin of the Astronomical Institutes of the Netherlands*	Netherlands	44	19.56	19.56	1922	1968
2	*Astronomy and Astrophysics*	Sweden	12	5.34	24.90	1970	1984
3	*Transactions of the International Astronomical Union*	UK	7	3.11	28.01	1962	1971
4	*Astrophysical Journal*	USA	6	2.67	30.68	1940	1977
5	*The Observatory*	UK	6	2.67	-	1926	1986
6	*Zenit, 1. Jaarg.*	***	6	2.67	36.02	1974	1989
7	*Monthly Notices of the Royal Astronomical Society*	UK	4	1.79		1939	1960
8	*Nature*	UK	4	1.79	39.60	1951	1971
9	*Annual Review of Astronomy and Astrophysics*	USA	3	1.35		1977	1983
10	*Astronomical Journal*	USA	3	1.35		1924	1960
11	*L'Astronomie*	France	3	1.35		1948	1965
12	*Mercury*	USA	3	1.35		1984	1992
13	*Popular Astronomy*	USA	3	1.35		1924	1947
14	*Publications of the Astronomical Society of the Pacific*	USA	3	1.35		1942	1976
15	*Scientific American*	USA	3	1.35		1956	1975
16	*Proceedings of the National Academy of Sciences of the United States of America*	USA	3	1.35	50.40	1924	1960
17	*Annales d'Astrophysique*	France	2	0.89		1938	1960
18	*Publications of the American Astronomical Society*	USA	2	0.89		1927	1927
19	*Comptes Rendus l'Academie des Sciences*	France	2	0.89		1957	1963
20	*Hemel en Dampkring*	***	2	0.89		1969	1973
21	*Mitteilungen der Astronomischen Gesellschaft*	Germany	2	0.89		1956	1973
22	*Monthly Notes of the Astronomical Society of South Africa*	South Africa	2	0.89		1952	1952
23	*Sterne und Weltraum*	Germany	2	0.89	56.63	1982	1982
24	*American Scientist*	USA	1	0.44		1960	1960
25	*Annalen van de Sterrewacht te Leiden*	USA	1	0.44		1928	1928
26	*Annals of the New York Academy of Sciences*	USA	1	0.44		1972	1972
27	*Astronomical Herald*	Japan	1	0.44		1988	1988
28	*Astronomical Society of Japan, Publications*	Japan	1	0.44		1988	1988
29	*Bulletin of the American Astronomical Society*	USA	1	0.44		1971	1971
30	*Ciel et Terre*	USA	1	0.44		1953	1953
31	*Comments on Modern Physics, Part C - Comments on Astrophysics*	UK	1	0.44		1977	1977
32	*Die Naturwissenschaften*	USA	1	0.44		1954	1954
33	*Memorie della Societa Astronomica Italiana*	Itally	1	0.44		1982	1982
34	*Nova Acta Leopoldina, Neue Folge*	Germany	1	0.44		1975	1975
35	*Publications of the Astronomical Society of Japan*	Japan	1	0.44		1988	1988
36	*Publications of the Kapteyn Astronomical Laboratory Groningen*	Netherlands	1	0.44		1926	1926
37	*Science News*	USA	1	0.44		1980	1980
38	*Science*	USA	1	0.44		1970	1970

Contd—

Table 6—Channel-wise publications —*Contd*

Sl. no.	Communication channels	Country	Paper	%	CMT %	FYP	LYP
39	*Sky and Telescope*	USA	1	0.44		1956	1956
40	*Space Science Reviews*	Germany	1	0.44		1971	1971
41	*The Messenger*	Germany	1	0.44		1979	1979
42	*Vistas in Astronomy*	Netherlands	1	0.44	64.99	1955	1955
Group: B	***Conference Proceedings, Symposiums, etc(CPS)[28.41%]***						
43	*Large Radio-Telescopes: Proceedings of the OECD Symposium...*	France	4	1.79		1961	1961
44	*The Distribution and Motion of Interstellar Matter in Galaxies : Proceedings...*	USA	4	1.79	68.57	1962	1962
45	*The Galaxy and the Magellanic Clouds: Proceedings...*	Australia	3	1.35		1964	1964
46	*Ricerche Astronomiche, Vol. 5, Specola Vaticana: Proceedings...*	Netherlands	3	1.35		1958	1958
47	*The Spiral Structure of our Galax: Proceedings...*	Netherlands	3	1.35	72.62	1970	1970
48	*Astrophysical cosmology: Proceedings...*	Italy	2	0.89		1982	1982
49	*Gas Dynamics of Cosmic Cloud: Proceedings...2*	Netherlands	2	0.89		1955	1955
50	*La Dynamique des galaxies spirales : [colloque] hautes etudes scientifiques.*	France	2	0.89		1975	1975
51	*Memoria del V Congreso Internacional de Radiacion Cosmic: Proceedings...*	México	2	0.89		1958	1958
52	*Niels Bohr Institut, Teknisk Videnskabelige Forskningsrad, and Nordisk Institut for Teoretisk Atomfysik, Symposium...*	Denmark	2	0.89		1978	1978
53	*Paris Symposium on Radio Astronomy: IAU Symposium...*	USA	2	0.89		1959	1959
54	*Problems of Cosmical Aerodynamics: Proceedings ...*	France	2	0.89		1951	1951
55	*Problems of Extra-Galactic Research: Proceedings ...*	USA	2	0.89		1962	1962
56	*The large-scale characteristics of the galaxy: Proceedings...*	Netherlands	2	0.89		1979	1979
57	*The Structure and Evolution of Galaxies.*	UK	2	0.89	81.52	1965	1965
58	*Texas Symposium on Relativistic Astrophysics*	USA	1	0.44		1981	1981
59	*Astronomical papers dedicated to Bengt Stromgren: Proceedings...*	Denmark	1	0.44		1978	1978
60	*Birth and Evolution of Massive Stars and Stellar Groups: Proceedings...*	Netherlands	1	0.44		1985	1985
61	*Clusters and Groups of Galaxies: International Meeting*	Netherlands	1	0.44		1984	1984
62	*Comparison of the Large-Scale Structure of the Galactic System with that of Other Stellar Systems: Proceedings...*	UK	1	0.44		1958	1958
63	*Dynamics of Stellar Systems: Proceedings ...*	Netherlands	1	0.44		1975	1975
64	*Early evolution of the universe and its present structure: Proceedings...*	Netherlands	1	0.44		1983	1983
65	*Evolution in the Universe: Proceedings...*	Germany	1	0.44		1982	1982
66	*Extragalactic radio sources: Proceedings...*	Netherlands	1	0.44		1982	1982
67	*Galactic Astronomy: Proceedings...*	USA	1	0.44		1970	1970

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Table 6—Channel-wise publications —*Contd*

Sl. no.	Communication channels	Country	Paper	%	CMT %	FYP	LYP
68	*Galactic Radio Astronomy: Proceedings...*	Netherlands	1	0.44			
69	*Galaxies and Relativistic Astrophysics: Proceedings...*	USA	1	0.44		1974	1974
70	*Galaxies and the Universe: Proceedings...*	USA	1	0.44		1968	1968
71	*Large-Scale Structure of the Universe, Cosmology and Fundamental Physics: Proceedings...*	Germany	1	0.44		1984	1984
72	*Lecture Notes of a NUFFIC International Summer Course in Science*	Netherlands	1	0.44		1960	1960
73	*Non-stable Phenomena in Galaxie:, proceedings...*	USA	1	0.44		1968	1968
74	*Pontificiae Academiae Scientiarum Scripta Varia: Proceedings...*	Netherlands	1	0.44		1971	1971
75	*Quasars and gravitational lenses: Proceedings...*	Belgium	1	0.44		1983	1983
76	*Radio Astronomy and the Galactic System: Proceedings...*	Netherlands	1	0.44		1967	1967
77	*Radio astronomy: Proceedings...*	UK	1	0.44		1957	1957
78	*Royal Greenwich Observatory Bulletins, Number 182.*	UK	1	0.44		1976	1976
79	*The big bang and Georges Lemaitre: Proceedings...*	Netherlands	1	0.44		1984	1984
80	*The formation and dynamics of galaxies: Proceedings...*	Australia	1	0.44		1974	1974
81	*The galactic center: Proceedings...*	USA	1	0.44		1982	1982
82	*The Magellanic Clouds: ... Symposium ...*	Netherlands	1	0.44		1971	1971
83	*The Milky Way Galaxy: Proceedings...*	Netherlands	1	0.44		1985	1985
84	*IAU Symposium*	Australia	1	0.44	93.40	1964	1964
Group : C	***Festschrift & books (F &B) [6.16%]***						
85	*Kinematics and ages of stars near the sun*	Germany	1	0.44		1974	1974
86	*Physics and chemistry of comets*	Germany	1	0.44		1990	1990
87	*Classics in Radio Astronomy*	Netherlands	1	0.44		1982	1982
88	*Galactic structure.*	USA	1	0.44		1965	1965
89	*La dynamique des galaxies spirales.*	France	1	0.44		1975	1975
90	*La Physique des Comètes*	***	1	0.44		1952	1952
91	*Les particules solides dans les astres.*	Belgium	1	0.44		1955	1955
92	*Oort and the Universe. A Sketch of Oort's Research and Person*	Netherlands	1	0.44		1980	1980
93	*Problems in theoretical physics and astrophysics*	Moscow	1	0.44		1989	1989
94	*Problems of Physics and Evolution of the Universe*	Armenia	1	0.44		1978	1978
95	*The Moon Meteorites and Comets,*	USA	1	0.44		1963	1963
96	*Structure and Evolution of Galaxies.*	Netherlands	1	0.44		1975	1975
97	*De oorsprong van het heelal*	***	1	0.44		1972	1972
98	*Handbuch der Physik*	USA	1	0.44	99.56	1959	1959
	Others (O)[0.44%]						
99*	*Sterne, 61. Band, Heft 5/6*	Germany	1	0.44	100	1985	1985
Total			225	100			

FYP = First year of publication, LYP = Last year of publication. CMT = Cumulative,

*** could not be ascertained

Table 7—Keywords (f ≥ 2)

Sl. no.	Keywords	Frequency (f)
1.	Galaxy(ies)	23
2.	Galactic system	17
3.	Structure	17
4.	Origin	14
5.	Universe	12
6.	Stars	10
7.	Evolution	9
8.	High Velocity Cloud	8
9.	Motion	8
10.	Spiral structure	8
11.	Super clusters	8
12.	Comets	7
13.	Crab Nebula	6
14.	Galactic center	6
15.	Dynamics	5
16.	Galactic Rotation	5
17.	Nuclei/Nucleus	5
18.	Velocity(ies)	5
19.	Density distribution	4
20.	Extragalactic nebulae	4
21.	High velocities	4
22.	Interstellar Gas	4
23.	large-scale structures	4
24.	Stellar system	3
25.	Average velocity	3
26.	Binaries	3
27.	Central region	3
28.	Faint Stars	3
29.	Galactic plane	3
30.	Globular clusters	3
31.	Hyades cluster	3
32.	Interstellar clouds	3
33.	luminosities	3
34.	Obituary(ies)	3
35.	Quasars	3
36.	Radio Emission	3
37.	single stars	3
38.	Sun	3
39.	Système galactique	3
40.	21-cm line	2
41.	Astronomy	2
42.	Clusters	2
43.	Density	2
44.	Elliptical Nebulae	2
45.	Galactic nucleus	2
46.	Galactic Structure	2
47.	Gas	2
48.	Halo	2
49.	Interstellar hydrogen	2
50.	Interstellar Hydrogen Line	2
51.	J. H. Oort	2
52.	K	2
53.	Leiden	2
54.	Long-period variables	2
55.	Neutral hydrogen	2
56.	NGC 1275	2
57.	NGC 4258	2
58.	O-Associations	2
59.	Proper motion	2
60.	Radial velocity(ies)	2
61.	RR Lyrae variables	2
62.	Spiral Galaxies	2
63.	Supernova	2
64.	Thirteenth magnitude	2

published 12 papers during 1970 to 1984. His papers were published in journals & periodicals (64.99%), conference proceedings, symposium, etc (28.41%) and Festschrift/books(6.16%) and they emanated from Netherland (71), USA (55),UK (27), Sweden (12),Germany (12), France (16), Australia (05), Japan (03), Denmark(03), Italy (03),Belgium (02), México (02),Armenia (01),Russia (01).Moscow (01) and South Africa(01).

Bradford law and the data set

In Bradford distribution, each of three zones should have roughly 33% of the papers. Less than this percentage in a zone tends to indicate the deviation from Bradford's law[33,35]. Table 6 indicates that 225 papers are published in 99 channels. In each zone there should be around 75 papers (nearly). The first five periodicals accounting for 75 papers create the first zone. The next 75 papers are accounted for by 38 periodicals. This indicates that the value of *n or Bradford multiplier* is 38/5 = 7.6. The third zone should have 5x7.6x7.6=288.8 periodicals. In reality we have only 56 periodicals/communication channels i.e., much less than the required number. The data set does not follow Bradford's law.

Keywords

Table 7 depicts frequency of keywords that have occurred twice or more. Two hundred and fifty two keywords have appeared in 225 papers. Out of them the keyword Galaxy(ies) has appeared in 23 titles followed by Galactic system(17), Structure (17), Origin (14), Universe (12), Stars(10) and Evolution(9). The four keywords High Velocity

Cloud, Motion, Spiral structure and Super clusters; have been used 8 or more times each. The keyword Comets has occurred 7 times and the two keywords Crab Nebula and Galactic center have appeared six times each viz., four keywords has Dynamics, Galactic Rotation, Nuclei/Nucleus and Velocity(ies) have appeared five times and so on as given in the table.

Conclusion

This biobibliometric study highlights the various aspects of the career of the Dutch astronomer Jan Hendrik Oort. He remained a prolific author with nearly 3 papers per year during 71 years of his career and after his retirement he authored four to five papers per year. His most notable research works were on the 'Structure' of 'Galaxy(ies)' and 'Galactic system'. J H Oort breathed his last on 5 November1992 in Leiden, of South Holland at the age of 93. Oort is remembered as one of the most influential and the greatest astronomers of the 20th century[44].

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