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**Research Trends in Physics: A Scientometric Study of Publication Productivity, Authorship Patterns and Channels of Communications of Physics Nobel Laureate – YoichiroNambu**

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**Abstract**

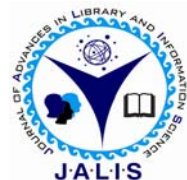
*Scientometric analysis of the 293 publications by YoichiroNambu published during 1948-2010 has been done in the present paper. The result of the study shows that YoichiroNambu had published 73 single-authored and 220 multi-authored publications during 1948-2010. The multi-authored publications include: two-authored (73), three authored (53), four authored (24), five authored (14), six authored (9), seven authored (7), eight authored (13), nine authored (6) and ten and above authored (20). His highest productivity was in 1998 with the output of 14 publications (age 77,) followed by 12 publications in 1990 (age 69), 11 publications each in 1985 (age, 64 years), 1988 (age, 67 years) and 2000 (age, 79 years). The 50 percentile productivity life was 31 at the age of 57 years. The total productivity life of the author spans 63 years from the age of 27. YoichiroNambu has received 15,518 citations for his 293 articles and his h-index 46.*

**Keywords**

Scientometrics; Scientometric Portrait; Nobel Laureate; h-Index

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**INTRODUCTION**

The term Scientometrics originated as a Russian term for the application of quantitative methods to the history of science. This term was introduced and came into prominence with the founding of the journal named 'Scientometrics' by T. Braunin 1977, originally published in Hungary and currently from Amsterdam. Scientometrics used to mean communication process in science including socio-cultural aspects and appears to be almost synonymous of science with more stress on quantitative aspects. It also used as a generic term for a system of knowledge, which endeavors to study the scientific (and technological) system using a variety of approaches within the area of science and technology studies. Thus, Scientometrics is a part of the sociology and has application to science policy making [1].

Bio-bibliometrics is a term that was first coined by *Sen and Gan*[2] to mean the quantitative and analytical method for discovering and establishing functional relationships between bio-data and biblio-data elements. *Kademani and Kalyane*[3-4] were the first to use the phrase "Scientometric portrait" to carry out bio-bibliometric studies on scientists including Nobel laureates [5]. Recently the term 'Bio-bibliometrics' is being used for method of retrieving and visualizing biological information that uses co-occurrence of gene naming terms in Medical Sciences to generate semantic links between genes. Therefore, it is suggested that '*Scientometric portrait*' is the appropriate phrase for the studies on scientists, and 'Informetric portrait' for the studies on researchers in other disciplines such as arts, humanities, and social sciences [6].

YoichiroNambu was born in Tokyo, Japan, in the year 1921. After graduating from the then Fukui Secondary High School in Fukui City, he enrolled in the Tokyo Imperial University and studied physics. He received his B.S. in 1942 and D.Sc. in 1952. In 1949, he was appointed as associate professor at the Osaka City University and promoted to professorship the next year at the age of 29. YoichiroNambu is known for his contributions to the field of theoretical physics; he was awarded a one-half share of the Nobel Prize in Physics in 2008 for the discovery of the mechanism of spontaneous broken symmetry in subatomic physics. The other half share was split equally between Makoto Kobayashi and Toshihide Maskawa for the discovery of the origin of

the broken symmetry which predicts the existence of at least three families of quarks in nature [7].

In the present paper an attempt has been made to investigate the scientific work done by the Noble Laureate of 2008 Yoichiro Nambu (Japan) and his role for the advancement of science and technology in the world.

**OBJECTIVES OF THE STUDY**

1. To investigate the number of articles contributed by Yoichiro Nambu;
2. Publication productivity and authorship patterns of Yoichiro Nambu in various scientific domains
3. Dissemination of the channels of communication used by Yoichiro Nambu;

4. To calculate the h-index of Yoichiro Nambu.

**DATA AND METHODOLOGY**

The data source for the study is ISI Web of Science, Science Citation Index, published by Thomson Scientific. It is the world's leading abstracting & indexing service providing on all aspects of science. By using suitable strategy related to literature produced by Physics Nobel Laureates, the bibliographic details for each record included author, author's affiliation, title, type of document, source of publication, year of publication, keywords, language of the article and country of input have been collected. Further all the bibliographic details have been transferred to a spreadsheet. Later the data was analyzed as per the objectives of the study.

**Table 1: Publication Productivity of Yoichiro Nambu in Chronological Order**

APL	Year	Single & Multi-Authored Papers										MT	TP	AA		
		1	2	3	4	5	6	7	8	9	>10					
1	1948	1													1	27
2	1949	4		1										1	5	28
3	1950	4	2											2	6	29
4	1951		1	2										3	3	30
5	1952	2													2	31
6	1953															32
7	1954		1											1	1	33
8	1955	2													2	34
9	1956	2													2	35
10	1957	2		1	2									3	5	36
11	1958	1		1										1	2	37
12	1959															38
13	1960	2	1		1									2	4	39
14	1961	1	4											4	5	40
15	1962	1	4											4	5	41
16	1963		6											6	6	42
17	1964	1	5											5	6	43
18	1965		3	1										4	4	44
19	1966	1	2	1										3	4	45
20	1967	1													1	46
21	1968	2	2											2	4	47
22	1969															48
23	1970		2	1										3	3	49
24	1971	1													1	50
25	1972		1											1	1	51
26	1973	1													1	52
27	1974	1	1											1	2	53
28	1975		1											1	1	54
29	1976	1	2											2	3	55

30	1977	1					1					1	2	56
31	1978	2											2	57
32	1979	2		1								1	3	58
33	1980	1		2								2	3	59
34	1981	1		2								2	3	60
35	1982		1	1	1							3	3	61
36	1983	1		1	2							3	4	62
37	1984	2			2					1		3	5	63
38	1985	2	2	7								9	11	64
39	1986			2	1		1					4	4	65
40	1987			1	1							2	2	66
41	1988		3	5	3							11	11	67
42	1989	1	2	3	1	1						7	8	68
43	1990	1	3	4	2	1			1	1		11	12	69
44	1991	3	2	2	2				1			7	10	70
45	1992	2	1	2	1	1		1				7	9	71
46	1993	2	2	3				1				6	8	72
47	1994	1	2				1	1				4	5	73
48	1995		1	3								4	4	74
49	1996		2	1	1					1		5	5	75
50	1997	1	1						1			2	3	76
51	1998	3	4		1	2	1	1	1		1	11	14	77
52	1999		1		1	1	1		1			2	7	78
53	2000	2		1	1	1					6	9	11	79
54	2001	1								2	4	6	7	80
55	2002	1	2	1		1			2	1	1	8	9	81
56	2003		2			2	1		3			8	8	82
57	2004	1	2	1		2	1					6	7	83
58	2005	1	1							1	1	3	4	84
59	2006		1	2					2			5	5	85
60	2007	3					1		1	2	1	4	7	86
61	2008	2				1		2				3	5	87
62	2009	4			1		1					2	6	88
63	2010	1						2	1		1	5	6	89
	<b>Total</b>	<b>73</b>	<b>73</b>	<b>53</b>	<b>24</b>	<b>14</b>	<b>9</b>	<b>7</b>	<b>13</b>	<b>7</b>	<b>20</b>	<b>220</b>	<b>293</b>	

APL= Age of Productive Life; MT= Total of Multi-Authored Publications; TP = Total Publications; and AA= Biological Age of the Author.

YoichiroNambu had 73 single-authored and 220 multi-authored publications published during 1948-2010. The multi-authored publications include: two-authored (73), three authored (53), four authored (24), five authored (14), six authored (09), seven authored (07), eight authored (13), nine authored (06), and ten and above authored (20). Table (1) shows that, the first publication of the author was published in 1948 when he was 27. YoichiroNambu

had no publications during 1953, 1959 and 1969. His highest productivity was in 1998 with the output of 14 publications (age 77) followed by 12 publications in 1990 (age 69), 11 publications each in 1985 (age, 64 years), 1988 (age, 67 years) and 2000 (age, 79 years). The 50 percentile productivity life was 31 at the age of 57 years. The total productivity life of the author spans 63 years from the age of 27.

**Table 2: Publication Productivity and Authorship Patterns of YoichiroNambu in Various Scientific Domains**

No. of Authors	Domains				Total No. of Papers	%	Total No. of Authorship	%
	A	B	C	D				
1 - Author	70		1	2	73	24.91	73	7.02
2 - Authors	63	2	2	6	73	24.91	146	14.05
3 - Authors	23	1	4	25	53	18.08	159	15.3
4 - Authors	11	1	5	7	24	8.19	96	9.23
5 - Authors	6	1	4	3	14	4.77	70	6.73
6 - Authors	4		5	0	9	3.07	54	5.19
7 - Authors	3	2	2	0	7	2.38	49	4.71
8 - Authors	5		6	2	13	4.43	104	10
9 - Authors	1	2	2	2	7	2.38	63	6.06
10 - Authors		1	7	2	10	3.41	100	9.62
11 - Authors	1		2		3	1.02	33	3.17
12 - Authors			3		3	1.02	36	3.46
13 - Authors			1	1	2	0.68	26	2.5
14 - Authors								
>15 - Authors			1	1	2	0.68	30	2.88
<b>Total</b>	<b>187</b>	<b>10</b>	<b>45</b>	<b>51</b>	<b>293</b>	<b>100</b>	<b>1039</b>	<b>100</b>

A= Physics, Applied Physics, Optics, and Material Science; B= Engineering - Electrical, Electronics and Mechanical; C = Oncology/Biophysics, Biochemistry, Biology, Biotechnology, Radiology, Chemistry, Medicine, Respiratory System, Surgery, Immunology and Clinical Neurology;D= Multidisciplinary Science.

Table (2) shows, YoichiroNambu had total 293 publications out of which 187 publications were in domain A, followed by 10 publications in domain B, 45 publications in domain C, and 51 publications in domain D.

**Table 3: Dissemination of the Channels of Communication Used by YoichiroNambu**

SI No.	Channels of Communication	No. of Papers	Cumulative	Period of Journal	TY
1	Progress of Theoretical Physics	26	26	1948-2004	57
2	Physical Review	20	46	1954-1968	15
3	Physical Review Letters	20	66	1960-2010	51
4	Physical Review D	18	84	1971-2005	35
5	Journal of Polymer Science Part A-Polymer Chemistry	15	99	1979-1996	18
6	Physics Letters B	12	111	1968-1998	31
7	Journal of Organic Chemistry	6	117	1982-1993	12
8	NuovoCimento	6	123	1957-1963	7
9	Physical Review A	6	129	1987-2003	17
10	Applied Physics Letters	5	134	1990-2009	20
11	Progress of Theoretical Physics Supplement	5	139	1991-2007	17
12	Supplement of the Progress of Theoretical Physics	5	144	1965-1985	21
13	Classical and Quantum Gravity	4	148	1996-2002	7
14	International Journal of Modern Physics A	4	152	1993-2010	18
15	Macromolecules	4	156	1987-1991	5
16	American Journal of Respiratory & Critical Care Medicine	3	159	1999	1

17	Annals of Physics	3	162	1957-1989	33
18	Japanese Journal of Applied Physics Part 1- Regular Papers Short Notes & Review Papers	3	165	1986-1999	14
19	Journal of Animal Breeding and Genetics- Zeitschrift Furtierzuchtung Und Zuchtungsbiologie	3	168	1989-1990	2
20	Journal of Nuclear Medicine	3	171	1998-2008	11
21	Journal of Polymer Science Part C-Polymer Letters	3	174	1985-1989	5
22	Journal of the physical Society of Japan	3	177	1998-2007	10
23	Nuclear Physics A	3	180	1998-2008	11
24	Nuclear Physics B	3	183	1977-2000	24
25	Physics Letters	3	186	1964-1965	2
26	Bulletin of the Chemical Society of Japan	2	188	1981-1983	3
27	Chemistry Letters	2	190	1985	1
28	EJC Supplements	2	192	2007-2008	2
29	Faseb Journal	2	194	2000-2003	4
30	Japanese Journal of Applied Physics Part 2- Letters & Express Letters	2	196	2004	1
31	Japanese Journal of Applied Physics Part 1- Regular Papers Brief Communications & Review Papers	2	198	2006	1
32	Journal of Applied Physiology	2	200	2001	1
33	Journal of the Chemical Society-Chemical Communications	2	202	1986-1992	7
34	Journal of Vaccum Science & Technology B	2	204	1996-1998	3
35	Molecular carcinogenesis	2	206	1998	1
36	Nippon Kagaku Kaishi	2	208	1976-1993	18
37	Physics reports - Review Section of Physics Letters	2	210	1984	1
38	Physics Today	2	212	2006-2009	4
39	Reviews of Modern Physics	2	214	1964-2009	46
40	Science	2	216	2003-2005	3
41	Scientific American	2	218	1976-1998	23
42	Tetrahedron Letters	2	220	1990	1
43	Advanced Materials	1	221	1993	1
44	American Journal of Pathology	1	222	2001	1
45	American Review of Respiratory Disease	1	223	1993	1
46	Applied Spectroscopy	1	224	1986	1
47	Astrophysical Journal	1	225	1991	1
48	Biochemical and biophysical Research Communications	1	226	2005	1
49	Blood	1	227	1999	1
50	British Journal of Cancer	1	228	2010	1
51	Bulletin of the American Physical Society	1	229	1970	1
52	Cancer Research	1	230	1997	1
53	Chemphyschem	1	231	2009	1
54	Chest	1	232	1994	1
55	Clinical Neuropathology	1	233	1992	1
56	Electronics Letter	1	234	2003	1
57	EPILEPSIA	1	235	1977	1
58	European Journal of Nuclear Medicine	1	236	2000	1

59	Experimental Lung Research	1	237	2001	1
60	IEEE Journal of Quantum Electronics	1	238	1994	1
61	IEEE Journal of Solid-State Circuits	1	239	1990	1
62	International Immunology	1	240	2006	1
63	International Journal of Theoretical Physics	1	241	1978	1
64	Japanese Journal of Pharmacology	1	242	2001	1
65	Journal of Biological Chemistry	1	243	2002	1
66	Journal of Biotechnology	1	244	1986	1
67	Journal of Clinical Investigation	1	245	1998	1
68	Journal of Clinical Oncology	1	246	2009	1
69	Journal of Experimental Medicine	1	247	2003	1
70	Journal of Liquid Chromotography & Related Technologies	1	248	1999	1
71	Journal of Magnetism and Magnetic Materials	1	249	2007	1
72	Journal of Molecular catalysis	1	250	1983	1
73	Journal of Molecular Medicine - JMM	1	251	2004	1
74	Journal of Physical Chemistry	1	252	1992	1
75	Journal of Physics Condensed Matter	1	253	2010	1
76	Journal of Statistical Physics	1	254	2004	1
77	Journal of Synthetic Organic Chemistry Japan	1	255	1985	1
78	Journal of the Japanese Society for Food Science and Technology-Nippon Shokuhin Kagaku Kogaku Kaishi	1	256	1985	1
79	Journal of Thoracic and Cardiovascular Surgery	1	257	2002	1
80	Lecture Notes in Physics	1	258	1983	1
81	Makromolekulare Chemie-Macromolecular Chemistry and Physics	1	259	1988	1
82	Makromolekulare Chemie-Rapid Communications	1	260	1980	1
83	Modern Physics Letters A	1	261	2000	1
84	NEC Research & Development	1	262	2003	1
85	Nuclear Medicine Communications	1	263	2000	1
86	Nuovo Cimento A	1	264	1966	1
87	Optical and Quantum Electronics	1	265	1992	1
88	Physica A	1	266	1979	1
89	Physica B&C	1	267	1984	1
90	Physica D	1	268	1985	1
91	Physical Review A-General Physics	1	269	1964	1
92	Physical Review B	1	270	1994	1
93	SCIENCE-New York	1	271	1992	1
94	Tohoku Journal of Experimental Medicine	1	272	1999	1
95	Transplantation	1	273	2000	1
96	Uspekhi Fizicheskikh Nauk	1	274	1978	1
97	Zeitschrift Fur Naturforschung Section A-A Journal of Physical Sciences	1	275	1997	1
98	Books / Chapters / Talks / Others	18	293	1991-2009	19

Distributions of Yoichiro Nambu's 293 publications published in 97 Journals and 18 in books/chapters and conference proceedings. Journal-wise scattering of publications of Yoichiro Nambu is provided in

Table (3). Top ranking journals with a number of publications are: Progress of Theoretical Physics (26), Physical Review (20), Physical Review Letters (20) and Physical Review D (18).

**Table 4: Authorship Pattern and Collaborative Measures**

Nobel Laureate	Authorship Pattern& Collaborative Measures									
	1	2	3	4 &>	Citations	h-Index	TP	CI	DC	CC
YoichiroNambu	73	73	53	94	15,518	46	293	0.28	0.75	0.51

*1= Single Author; 2= Two Authors; 3= Three Authors; 4= 4 and Above Authors; TP=Total Publications; CI = Collaborative Index; DC = Degree of Collaboration; CC = Collaborative Coefficient.*

Table (4) indicates that, YoichiroNambu has received 15,518 citations for his 293 publications and his h-index 46.

**CONCLUSION**

Scientometric study plays an important role in the dissemination of particular scientists whose interest lies in the number of important papers he or she published. The above study on YoichiroNambu undoubtedly proves the usefulness of his work to the field of science and technology gives an indication about the inspiration to young scientists throughout the world.

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