DST-NRF Centre of Excellence in Scientometrics and Science, Technology and Innovation Policy

Big Science, co-publication and collaboration: getting to the core

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A cautionary tale

- Rise in publication counts
- Rise in international co-authorship
- Changing geo-political realities
- Emergence of the BRICS
- The meaning of scientific collaboration

Figure 1.1. Proportion of global publication authorship by country[17]

The top ten producing countries in each period are shown. **Fig a.** *1999-2003.* **Fig b.** *2004-2008*

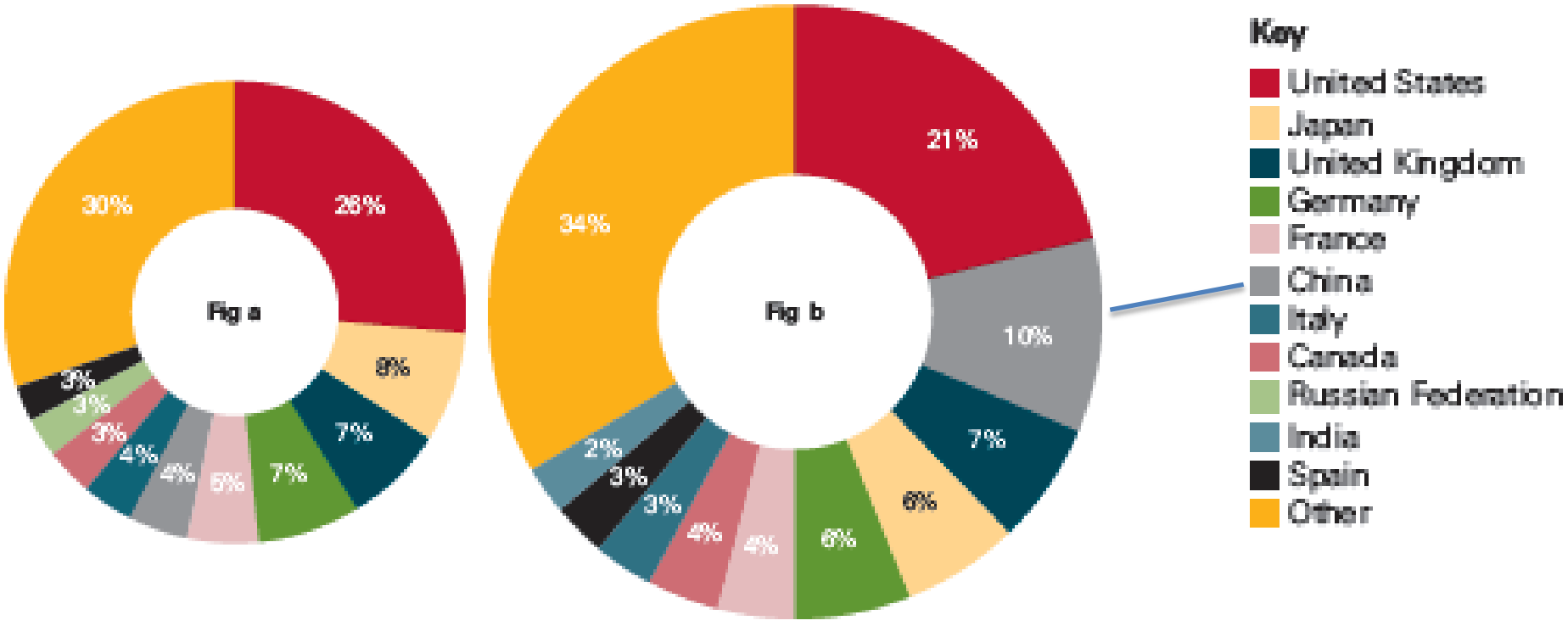
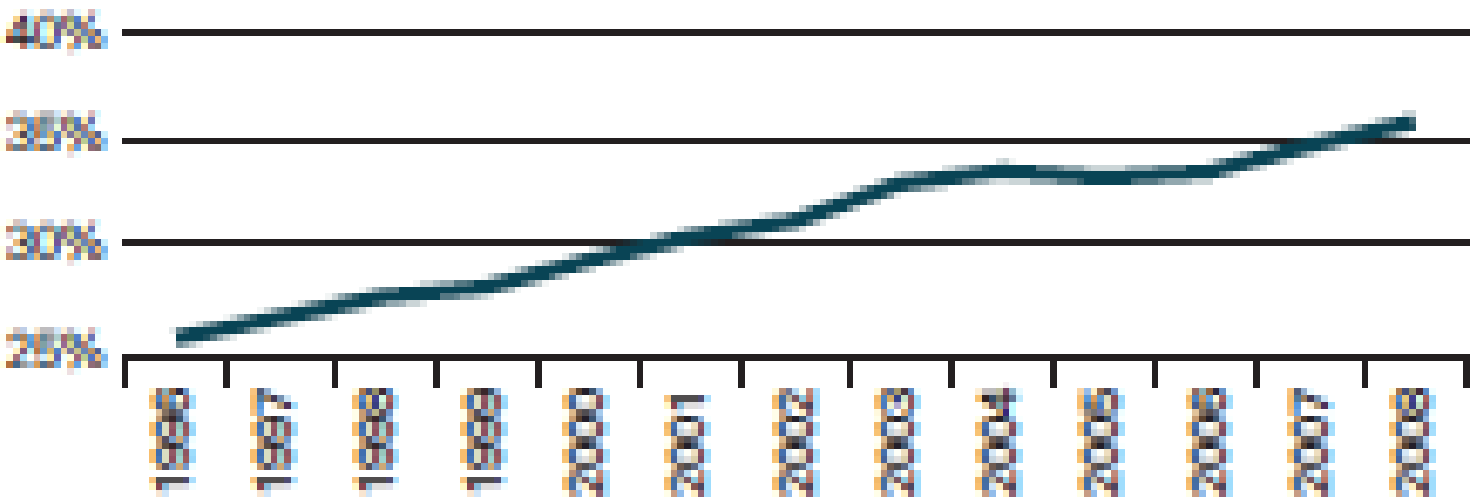


Figure 2.1. Increase in the proportion of the world's papers produced with more than one international author, 1996–2008.[161]



BRICS: Cape Town Declaration on S&T

- Brazil: Climate change and disaster mitigation
- Russia: Water resources and pollution treatment
- India: Geospatial technology and applications
- China: New and renewable energy/energy efficiency
- South Africa: Astronomy

Table 1: Some basic comparative indicators (2014)

	Brazil	Russia	India	China	S. Africa
GERD/GDP %	1.2	1.12	0.88	1.98	0.73
BERD/GERD %	45	26	30	74	47
Researchers/1000 employed	1.4	6.2	0.4*	1.8	1.6
Web of Science	36 111	27 303	46 348	183 760	9 217
Web of Science/m	180	191	38	136	181
Fields of publication	Clinical medicine Biology Biomedical	Physics Chemistry Engineering	Chemistry Clinical medicine Engineering	Chemistry Engineering Physics	Clinical medicine Biology Chemistry
USPTO/m	1.3	2.4	1.4	4.0	3.1
Plant cultivars in force/m	8.6	29.3	n.a.	2.6	48
Global Innovation Index	67	52	87	46	51
Gini coefficient	51.9	42.0	36.8	47.3	63.1
Decile 10/Decile 1	54	7	9	18	43
Human Development Index	85	55	136	101	121
CO_2 tonnes/capita	2.15	12.18	1.64	6.18	9.18

BRAZIL

WEB OF SCIENCE	%
Agriculture	7
Chemistry	7
Physics	6
Engineering	6
Biochem & mol bio	4

SCOPUS	%
Medicine	33
Agriculture & bioscience	20
Engineering	12
Biochem, genetics & mol bio	11
Physics & astronomy	10

NATIONAL THRUSTS
Biotechnology; Nanotechnology; Energy; ICT; Health; Biodiversity and the Amazon; Climate change; Space science; National security (MST, 2007)

BRICS THEME
CLIMATE CHANGE AND DISASTER MITIGATION

RUSSIA

WEB OF SCIENCE	%
Physics	25
Chemistry	16
Material science	7
Engineering	7
Mathematics	6

SCOPUS	%
Physics & astronomy	32
Engineering	20
Material science	18
Chemistry	14
Mathematics	11

NATIONAL THRUSTS
Energy; Nuclear, Strategic ICT; Health; Space science; (Meissner et al, 2013)

BRICS THEME
WATER RESOURCES & POLLUTION TREATMENT

INDIA

WEB OF SCIENCE	%
Chemistry	19
Physics	12
Engineering	11
Material science	10
S&T other	6

SCOPUS	%
Medicine	24
Engineering	22
Computer science	16
Chemistry	14
Physics & astronomy	13

NATIONAL THRUSTS
Sustainable agriculture, Health, Energy, Transport & infrastructure; Environment; Inclusion; Space S&T (Hoareau McGrath et al, 2014)

BRICS THEME
GEOSPATIAL TECHNOLOGIES AND APPLICATIONS

CHINA

WEB OF SCIENCE	%
Chemistry	18
Engineering	14
Material science	12
Physics	11
S&T other	8

SCOPUS	%
Engineering	39
Medicine	18
Material science	16
Physics & astronomy	15
Computer science	13

NATIONAL THRUSTS

Biotechnology; Food security; New energy sources & materials; Clean energy vehicles; Climate change and environment (Hoareau McGrath et al, 2014)

BRICS THEME

NEW & RENEWABLE ENERGY AND ENERGY EFFICIENCY

SOUTH AFRICA

WEB OF SCIENCE	%
Chemistry	6
Env sci & ecology	6
Infectious diseases	5
Engineering	5
Physics	5

SCOPUS	%
Medicine	33
Agriculture & biosciences	20
Engineering	12
Biochem, genetics & mol bio	11
Physics & astronomy	10

NATIONAL THRUSTS
Biotechnology; Energy supply; Climate change; Poverty alleviation; Space S&T (DST, 2008)

BRICS THEME
ASTRONOMY

Publication patterns

- The meaning of co-publication; prone to double and over-counting (Katz and Martin, 1997)
- Russia – low international co-authorship; highest BRICS concentration of physics & astronomy (Kumar and Asheulova, 2011)
- Yang et al (2012) – Russia & China heterogeneity across subject areas, India midway between homogeneous Brazil & South Africa.
- Yi et al (2013) South Africa least specialized; Russia most.

- Finardi (2015) collaboration among BRICS pairs weak cf collaborations w. US, UK, DE, FR Geographic distance weak effects
- Waltman et al (2011) e mean distance between parties collaborating in science rose from 334km in 1980 to 1553 in 2009
- Attests to dispersed nature of the ‘new invisible college of science’ (Wagner, 2008)
- Study restricted to 2009 to 2014

Table 2: BRICS research areas and h-indices, Web of Science Core Collection, 2014

BRAZIL 51639		RUSSIA 39963		INDIA 77369		CHINA 329976		SOUTH AFRICA 15337	
Research Area %	**h**	**Research Area %**	**h**	**Research Area %**	**h**	**Research Area %**	**h**	**Research Area %**	**h**
Engineering 8.50	11	Physics 26.00	30	Engineering 17.73	24	Engineering 21.75	41	Engineering 7.88	11
Agriculture 7.25	10	Chemistry 14.21	20	Chemistry 16.50	29	Material sci 16.24	54	Environment 5.89	12
Chemistry 6.99	15	Engineering 10.09	12	Physics 12.32	24	Chemistry 14.80	51	Chemistry 5.38	13
Physics 6.54	22	Material sci 8.50	7	Material sci 10.45	21	Physics 9.99	52	Physics 5.33	17
-		-		-		-		-	
-		-		-		-		-	
Astronomy 1.98	20	Astronomy 4.10	35	Astronomy 1.57	35	Astronomy 0.67	24	Astronomy 3.39	36

h-index scale factor

WoS and Scopus views

Table 3: Leading co-publication count Web of Science (upper diagonal); Scopus (lower diagonal), 2009-2014

	Brazil	**Russia**	**India**	**China**	**South Africa**
Brazil		*Phys 69.0* *Astron 27.2*	*Phys 46.2* *Astron 18.8*	*Phys 48.6* *Astron 20.6*	*Phys 35.8* *Astron 17.9*
Russia	Phys & Astro 74.6		*Phys 64.1* *Astron 35.3*	*Phys 52.2* *Astron 20.4*	*Phys 50.0* *Astron 31.1*
India	Phys & Astro 46.4	Phys & Astro 72.1		*Phys 31.0* *Astron 12.8*	*Phys 19.4* *Astron 11.1*
China	Phys & Astro 50.9	Phys & Astro 58.4	Phys & Astro 33.5		*Phys 32.0* *Astron 13.9*
South Africa	Phys & Astro 38.1	Phys & Astro 63.2	Phys & Astro 27.7	Phys & Astro 36.5	

Physics co-authorship h-index

¤	Brazil¤	Russia¤	India¤	China¤	South Africa¤
Brazil¤	¤	20¤	20¤	20¤	15¤
Russia¤	20¤	¤	20¤	17¤	15¤
India¤	20¤	20¤	¤	21¤	15¤
China¤	20¤	17¤	19¤	¤	16¤
South Africa¤	15¤	15¤	15¤	16¤	¤

Astro co-authorship h-index

Table 5: Co-publication h-index for Astronomy and Astrophysics, Web of Science (upper diagonal), Scopus (lower diagonal) 2014

	Brazil	**Russia**	**India**	**China**	**South Africa**
Brazil		17	16	18	11
Russia	17		35	19	33
India	16	35		16	33
China	18	19	16		13
South Africa	11	33	33	13	

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ASTRONOMY & ASTROPHYSICS Volume: 571 Article Number: A16 Published: NOV 2014
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Times Cited: 3,217 *(from Web of Science Core Collection)*
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2. **Planck 2013 results. XXII. Constraints on inflation**
By: Ade, P. A. R.; Aghanim, N.; Armitage-Caplan, C.; et al.
Group Author(s): Planck Collaboration
ASTRONOMY & ASTROPHYSICS Volume: 571 Article Number: A22 Published: NOV 2014
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Times Cited: 1,094 *(from Web of Science Core Collection)*
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3. **Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013**
By: Ng, Marie; Fleming, Tom; Robinson, Margaret; et al.
LANCET Volume: 384 Issue: 9945 Pages: 766-781 Published: AUG 30 2014
SFX | Full Text from Publisher | View Abstract
Times Cited: 868 *(from Web of Science Core Collection)*
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4. **Planck 2013 results. I. Overview of products and scientific results**
By: Ade, P. A. R.; Aghanim, N.; Alves, M. I. R.; et al.
Group Author(s): Planck Collaboration
ASTRONOMY & ASTROPHYSICS Volume: 571 Article Number: A1 Published: NOV 2014
SFX | View Abstract
Times Cited: 710 *(from Web of Science Core Collection)*
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5. **Planck 2013 results. XV. CMB power spectra and likelihood**
By: Ade, P. A. R.; Aghanim, N.; Armitage-Caplan, C.; et al.
ASTRONOMY & ASTROPHYSICS Volume: 571 Article Number: A15 Published: NOV 2014
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Times Cited: 382 *(from Web of Science Core Collection)*
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16. **Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013**

By: Wang, Haidong; Liddell, Chelsea A.; Coates, Matthew M.; et al.
LANCET Volume: 384 Issue: 9947 Pages: 957-979 Published: SEP 13 2014

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Times Cited: 125
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17. **First look at the physics case of TLEP**

By: Bicer, M.; Yildiz, H. Duran; Yildiz, I.; et al.
Group Author(s): TLEP Design Study Working Grp
JOURNAL OF HIGH ENERGY PHYSICS Issue: 1 Article Number: 164 Published: JAN 29 2014

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Times Cited: 118
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18. **Planck 2013 results. XI. All-sky model of thermal dust emission**

By: Abergel, A.; Ade, P. A. R.; Aghanim, N.; et al.
ASTRONOMY & ASTROPHYSICS Volume: 571 Article Number: A11 Published: NOV 2014

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Times Cited: 112
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19. **Genome sequence of a 45,000-year-old modern human from western Siberia**

By: Fu, Qiaomei; Li, Heng; Moorjani, Priya; et al.
NATURE Volume: 514 Issue: 7523 Pages: 445-+ Published: OCT 23 2014

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Times Cited: 102
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20. **Planck 2013 results. XIX. The integrated Sachs-Wolfe effect**

By: Ade, P. A. R.; Aghanim, N.; Armitage-Caplan, C.; et al.
Group Author(s): Planck Collaboration
ASTRONOMY & ASTROPHYSICS Volume: 571 Article Number: A19 Published: NOV 2014

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Times Cited: 99
(from Web of Science Core Collection)

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22. **Search for Invisible Decays of a Higgs Boson Produced in Association with a Z Boson in ATLAS**

By: Aad, G.; Abajyan, T.; Abbott, B.; et al.
Group Author(s): ATLAS Collaboration
PHYSICAL REVIEW LETTERS Volume: 112 Issue: 20 Article Number: 201802 Published: MAY 20 2014

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Times Cited: 85
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23. **Multidrug-Resistant Tuberculosis and Culture Conversion with Bedaquiline**

By: Diacon, Andreas H.; Pym, Alexander; Grobusch, Martin P.; et al.
Group Author(s): TMC207-C208 Study Grp
NEW ENGLAND JOURNAL OF MEDICINE Volume: 371 Issue: 8 Pages: 723-732 Published: AUG 21 2014

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Times Cited: 83
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24. **Integrated guidance on the care of familial hypercholesterolaemia from the International FH Foundation**

By: Watts, Gerald F.; Gidding, Samuel; Wierzbicki, Anthony S.; et al.
INTERNATIONAL JOURNAL OF CARDIOLOGY Volume: 171 Issue: 3 Pages: 309-325 Published: FEB 15 2014

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Times Cited: 81
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25. **Planck 2013 results. XXVI. Background geometry and topology of the Universe**

By: Ade, P. A. R.; Aghanim, N.; Armitage-Caplan, C.; et al.
Group Author(s): Planck Collaboration
ASTRONOMY & ASTROPHYSICS Volume: 571 Article Number: A26 Published: NOV 2014

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Times Cited: 79
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26. **Search for Dark Matter in Events with a Hadronically Decaying W or Z Boson and Missing Transverse Momentum in pp Collisions at root s=8 TeV with the ATLAS Detector**

By: Aad, G.; Abajyan, T.; Abbott, B.; et al.
Group Author(s): ATLAS Collaboration
PHYSICAL REVIEW LETTERS Volume: 112 Issue: 4 Article Number: 041802 Published: JAN 29 2014

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Times Cited: 79
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When Authorship Isn't Enough: Lessons from CERN on the Implications of Formal and Informal Credit Attribution Mechanisms in Collaborative Research

Jeremy Birnholtz
Journal of Electronic Publishing
Volume 11, Issue 1, Winter 2008
DOI: http://dx.doi.org/10.3998/3336451.0011.105

Probing deeper

- China highest h-index. Physics h-index high for all; Astro h-index high/much higher for 3 countries.
- BRICS 'collaborate' in physics and astronomy, so poor fit with Cape Town Declaration.
- Brazil: Phyics 6% of publications; co-publication in Phys with RICS 69%, 47%, 48%,33% respectively.
- Median level for Physics 47,5%; Astro median is 19,5% of all co-publications
- Visual scan of abstracts; keyword search; participation in CERN, Planck, Sloan etc

Conclusions & future development

- Phys/Astro collaboration dominated by Big Science
- Problem of attribution in large projects; rules of the game; lead author; inclusion of engineers
- What defines Big Science? N>20?
- Separate category for counting? Mandatory use of fractional counts Scaling? Field effects. *Nature* taking the lead with separate category Beware of distortions