

## South–South cooperation: The case of Indo-Chinese collaboration in scientific research

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International collaboration in scientific research is on the rise. As shown by Wagner and Leydesdorff<sup>1</sup>, international collaboration as measured by co-authorship in refereed papers is growing linearly in terms of the number of papers, but exponentially in terms of the number of international addresses. This is so because internationally co-authored papers are increasingly multinationally co-authored, indicating an inflation of international collaborations<sup>2</sup>. Much of these collaborations take place in a small number of industrially advanced countries, mostly belonging to the OECD.

Here we look at the collaboration between India and the People's Republic of China, the two most populous nations of the world with a hoary past. The two great civilizations have learnt from each other for many centuries since the days of Buddha and have had cultural and trade relations long before the well-

documented travels in India by Fahian and Xuanzang. In the past fifty years though, the two countries have gone through some border disputes and uneasy peace, but overall the two sides are keeping all doors open for improving bilateral relations. Indeed, in the past few years, bilateral trade between India and China has grown enormously. In mid-January 2008, India's Commerce Minister, Kamal Nath and his Chinese counterpart, Chen Deming agreed to raise the bilateral trade target to US\$ 60 billion by 2010, from the current level of US\$ 38.7 billion.

Independent India invested modestly in scientific research with a view to maintaining the traditions set by the early twentieth-century researchers like Srinivasa Ramanujan, C. V. Raman, J. C. Bose and M. N. Saha. Till a little over a decade ago, scientists in India were publishing a larger number of papers than those in China in journals indexed by *Science Citation Index*. In 1997, China overtook India when Chinese scientists published 17,177 papers in *SCI*-indexed journals, as against 16,909 papers published by Indian scientists<sup>3</sup>. Since then China has accelerated the pace of R&D and in 2007, China accounted for more than 2.76 times the number of papers from India!

Writing about science collaboration between India and China, Abrol and Rupal<sup>4</sup> mentioned that 'Bilateral science and technology contacts are flourishing. Research cooperation is blossoming. . .'. Our earlier studies<sup>5,6</sup> have shown that collaboration between the two countries was rather limited. We wanted to see if things have really changed.

Searching the *Web of Science* we found that during the eight years 2000–07, researchers from India and China have co-authored 1807 papers. Among these, 1682 papers were articles, 45 were reviews, 18 were letters and 36 were meeting abstracts. The number of Indo-Chinese papers has steadily increased over these eight years. From 124 papers in 2000, the number went up to 134 in 2001, 158 in 2002, 173 in 2003, 235 in 2004, 314 in 2005, 310 in 2006 and 361 in 2007.

In many of the 1807 papers, there were co-authors from other countries as well. The most important collaborating countries are USA, Russia, South Korea and Germany (Table 1). We have classified the papers resulting from collaboration between India and China. One is struck by the rather small number of letters.

Physics is by far the most prominent area of Indo-Chinese collaboration. Table 2

**Table 1.** Participation of other countries in papers resulting from Indo-Chinese collaboration

Country	2000–07	2007	2006
India	1807	361	310
China	1807	361	310
USA	884	170	133
Russia	664	123	97
South Korea	643	122	107
Germany	584	89	89
France	458	66	73
Japan	448	90	69
Taiwan	446	68	58
Switzerland	434	81	78
Poland	364	62	53
Brazil	335	67	67
The Netherlands	327	49	52
Australia	316	65	49
England	301	57	59
Austria	246	50	41
Mexico	235	49	45
Argentina	159	34	32
Colombia	152	28	32
Paper type			
Article	1682	332	281
Review	45	11	7
Letter	18	3	2
Meeting abstract	36	8	11

**Table 2.** Journals in which papers resulting from Indo-Chinese collaboration have appeared

Journal	Number of papers in		
	2007	2006	2000–07
<i>Physical Review Letters</i>	48	39	251
<i>Physics Letters B</i>	13	18	174
<i>Physical Review D</i>	32	26	129
<i>Physical Review C</i>	12	6	50
<i>European Physics Journal C</i>	1	4	19
<i>AIDS</i>	11	–	13
<i>Applied Physics Letters</i>	2	–	12
<i>Current Science</i>	2	2	11
<i>Inorganic Chemistry</i>	4	–	11
<i>Lancet</i>	–	5	11
<i>Astronomy and Astrophysics</i>	3	1	10
<i>Astrophysical Journal</i>	2	–	10
<i>Journal of Cataract and Refractive Surgery</i>	–	–	10

## COMMENTARY

lists the journals which have published a large number of papers resulting from Indo-Chinese collaboration. The top four journals in the list are all physics journals: *Physical Review Letters* (251 papers), *Physics Letters B* (174), *Physical Review D* (129) and *Physical Review C* (50). Papers in these four journals account for more than a third of all Indo-Chinese collaborative papers. Besides, there are papers in other physics and astrophysics journals. Physics is followed way behind by medicine. *Current Science* is the only Indian journal in this list to have published more than 10 papers. Significantly, no Chinese journal finds a place in the list.

Thomson Reuters, publisher of *Web of Science*, classifies journals by discipline. As things are not so clearly demarcated in science, often journals are classified under more than one discipline. Even so, one can get a rough idea of disciplines in which Indian and Chinese scientists often collaborate. Table 3 provides data on the number of papers classified by discipline. Note that the numbers will add up to much more than 1807, as papers (and journals) are often classified into more than one discipline. Multidisciplinary physics, physics of particles and fields, astronomy and astrophysics, nuclear physics and applied physics top the list with 468, 189, 181, 83 and 59 papers respectively.

In a large number of cases, India and China collaborate with partners from other countries. This is especially true in areas like experimental high energy physics. Institutions involved in writing jointly authored papers are listed in Table 4. Note that a large number of institutions outside of India and China are listed. In fact, among the 16 institutions that have taken part in collaborative research leading to at least 50 papers, 11 are outside the two countries and these include institutions in Russia, USA, South Korea, Japan and Australia.

Till 2003, only a small percentage (around three-fourth of 1%) of Indian papers was written in collaboration with Chinese authors. From 2004 onwards, there has been a slow but perceptible rise in collaboration. Currently, collaboration accounts for over 1% of Indian papers (Table 5). To see this in perspective we have looked at the collaboration of these two countries with a few industrially advanced countries and a few developing countries (Tables 6 and 7). As in Table 1,

**Table 3.** Areas in which Indian and Chinese researchers collaborate

Subject	Number of papers in		
	2007	2006	2000–07
Physics, multidisciplinary	67	68	468
Physics, particles and fields	43	40	189
Astronomy and astrophysics	44	31	181
Physics, nuclear	18	14	83
Physics, applied	14	14	59
Engineering, electrical and electronics	9	11	49
Biochemistry and molecular biology	14	11	46
Chemistry, inorganic and nuclear	7	4	46
Chemistry, physical	15	5	42
Environmental sciences	6	8	41
Plant sciences	6	10	39
Mathematics	4	9	34
Mathematics, applied	8	7	34
Multidisciplinary science	5	7	33
Polymer science	10	5	33
Infectious diseases	16	–	30

**Table 4.** Institutions involved in Indo-Chinese collaborative research

Institution	Number of Indo-Chinese papers		
	2007	2006	2000–07
Institute of High Energy Physics, Russia	98	83	557
Panjab University, India	91	77	485
University of Science & Technology, China	90	82	404
Korea University, South Korea	88	76	382
Chinese Academy of Sciences	85	72	415
Sungkyankwan University, South Korea	74	57	283
University of Illinois, USA	74	52	226
Tata Institute of Fundamental Research, India	72	73	465
Institute of Theoretical and Experimental Physics, Russia	71	62	414
Brookhaven Nat Lab, USA	66	55	298
Peking University, China	63	46	262
University of Tokyo, Japan	63	51	309
Seoul National University, South Korea	60	42	326
Tokyo Institute of Technology, Japan	60	46	290
Yonsei University, South Korea	59	49	295
University of Melbourne, Australia	52	35	231

**Table 5.** Indo-Chinese collaboration in science during 2000–07: about 1% of Indian papers is co-authored with China

Year	Papers – China	Papers – India	Indo-Chinese papers	Percentage of Indian papers
2000	31,016	18,140	124	0.68
2001	36,500	19,145	131	0.68
2002	41,293	20,658	158	0.76
2003	50,883	22,854	174	0.76
2004	69,904	24,696	235	0.95
2005	73,714	27,346	314	1.15
2006	90,569	30,875	310	1.00
2007	96,380	34,859	361	1.04

**Table 6.** Number of papers published by Indian researchers in co-authorship with researchers from selected countries during 2000–07

Year	China	Japan	South Korea	Brazil	USA	Germany	Russia	France
2000	124	321	71	59	1257	476	86	253
2001	131	358	74	66	1342	534	93	287
2002	158	436	172	82	1393	592	111	288
2003	174	498	175	81	1551	624	115	317
2004	235	527	250	106	1716	739	132	335
2005	314	595	314	143	1866	810	199	427
2006	310	635	409	147	2100	828	184	512
2007	361	628	500	170	2304	943	196	516
2000–07	1807	3998	1965	854	13529	5546	1116	2935
Paper type								
Article	1682	3754	1897	755	11836	5168	1039	2698
Review	45	105	35	36	451	161	36	86
Letter	18	38	7	5	179	33	6	18
Meeting abstract	36	39	13	38	747	121	24	80

**Table 7.** Number of papers published by Chinese researchers in co-authorship with researchers from selected countries during 2000–07

Year	Japan	South Korea	Brazil	USA	Germany	Russia	France
2000	1182	234	76	2662	752	183	355
2001	1478	298	86	3157	903	204	393
2002	1695	386	97	3666	1034	260	512
2003	2008	463	113	4482	1156	264	626
2004	2288	613	128	5215	1329	325	706
2005	2474	719	147	6305	1453	375	900
2006	2845	854	152	7563	1672	396	1005
2007	2835	1031	140	8619	1798	381	1107
2000–07	16805	4598	939	41669	10097	2388	5604
Paper type							
Article	15776	4347	845	36947	9348	2301	5112
Review	236	48	32	1032	227	42	139
Letter	84	18	8	253	59	4	25
Meeting abstract	504	132	44	2728	331	28	246

in these tables also we have included the number of different kinds of documents. For both India and China, USA and Germany are the leading collaborators. Clearly every country considered collaboration with China to a much larger extent than with India. The ratio of preferring China over India for different countries is: 4.2 for Japan, 3.52 for USA, 2.42 for South Korea, 2.30 for Russia and 1.95 for France.

The Indo-Chinese collaboration in science seems to be picking up, but may take a few years before it can be called significant or set the pace for South-South scientific collaboration. As pointed

out by Wagner and Leydesdorff<sup>1</sup>, the core group of nations responsible for international collaboration is shrinking. That is the nature of the dynamics of collaboration and network formation in science.

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2. Persson, O., Glanzel, W. and Danell, R., *Scientometrics*, 2004, **60**, 421–432.
3. Arunachalam, S., *Curr. Sci.*, 2008, **94**, 848–849.
4. Abrol, D. and Rupal, P., *SciDev. Net*, 14 May 2008.

5. Arunachalam, S., In *The Web of Knowledge: A Festschrift in Honor of Eugene Garfield* (eds Cronin, B. and Atkins, H. B.), Information Today Inc., Medford, NJ, USA, 2000, pp. 215–232.
6. Arunachalam, S. and Jinandra Doss, M., *Curr. Sci.*, 2000, **79**, 621–628.

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