



アジア・太平洋総合研究センター  
Asia and Pacific Research Center

# Recent Trends in China's Collaborative Research with Developed Countries

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Japan Science and Technology Agency  
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# Purpose and Research Items

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## ■ Research Purpose

To understand the current state of China's collaborative research with advanced nations, a country that has seen remarkable scientific and technological development in recent years.

## ■ Research Items

- ① Changes in the number of co-authored papers by field
- ② Changes in human mobility over time

# Summary

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## 1. Changes in Co-Authored Papers by Field

- From 2013 to 2022, over 60% of China's international co-authored papers were in the fields of engineering, chemistry, materials science, clinical medicine, and physics.
- A significant growth rate in international co-authored papers was observed in environmental and ecological sciences, engineering, agricultural sciences, computer science, materials engineering, and earth sciences between 2013–2017 and 2018–2022, with most fields nearly doubling.
- In terms of relative citation impact, a quality measure, this increase was most noticeable in the fields of psychiatry and psychology, mathematics, clinical medicine, and computer science.
- The slower growth rate of China's international co-authored papers in 2021, combined with the sudden decrease in the proportion of co-authorships with the United States, suggests a clear weakening of China's previously strong orientation toward international collaborative research. While the impact of the pandemic may have played a part, the sharp slowdown in international collaboration with the U.S. suggests factors beyond academic considerations, such as U.S.–China friction.

## 2. Changes in Personnel Exchange

- Chinese enthusiasm for studying abroad remains strong and has increased over the past decade. Compared to a decade ago, when the U.S. and UK accounted for over 60% of choices, destinations have diversified to include Australia, Japan, and South Korea, among others.
- While South Korea sends the largest number of students to China, there has been a strikingly rapid increase in students from Thailand, Pakistan, and India in recent years.
- Many Chinese researchers in science and technology fields pursue graduate studies abroad after university. The United States remains the dominant destination, followed by the EU. Furthermore, an increasing number of researchers choose to return to China after securing employment.



# 1. Changes in Co-Authored Papers by Field

## Reference Materials:

Clarivate China, "Current Status of China's International Scientific Research Collaboration 2023"

Institute of Science and Technology Information of China, "Statistical Data of Chinese S&T Papers"

NISTEP, "Scientific Research Benchmarking 2023"; "Science and Technology Indicators 2013, 2018, 2023"

# Summary

- For this survey, “international co-authored papers” refers to those published by authors from two or more countries or regions indexed in Web of Science (WoS).
- China's co-authored papers reached 147,000 in 2022, 2.9 times the 2013 figure. They accounted for 24.9% of co-authored papers worldwide. The number of co-authoring countries also increased from 191 countries and regions in 2013 to 204 countries (regions) in 2022.
- If we compare the periods 2013–2017 and 2018–2022, the top five countries with the most co-authored papers with China remained unchanged. In descending order, they were the United States, the United Kingdom, Australia, Canada, and Germany.
- Scientific research can be broadly categorized into the 22 Essential Science Indicators (ESI) research fields. If we apply this classification, China has produced the most co-authored papers over the past decade in Engineering, Chemistry, Materials Science, Clinical Medicine, and Physics.

## Essential Science Indicators 22 Fields

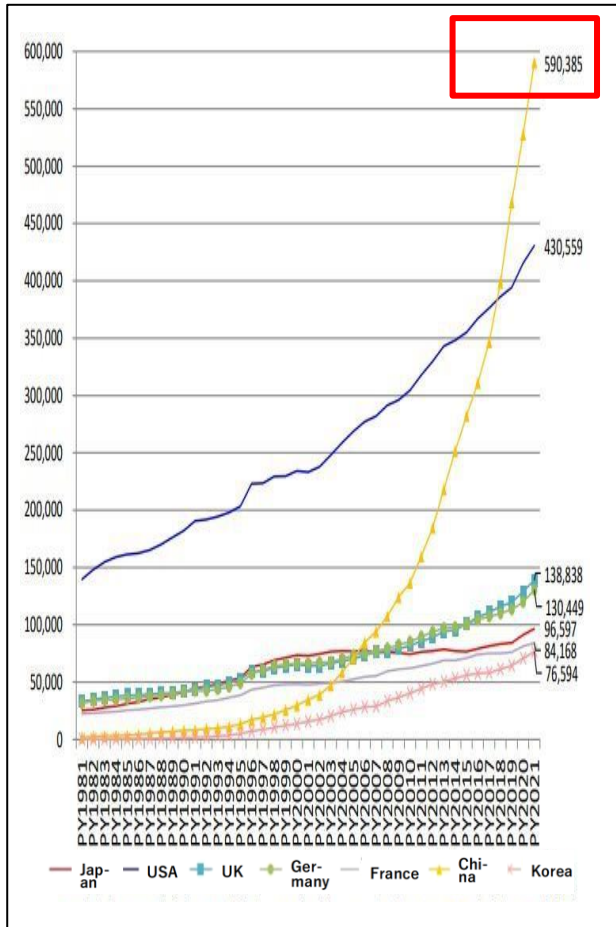
- |                                    |  |
|------------------------------------|--|
| ● Agricultural Science : 農業科学      | ● Mathematics : 数学                         |
| ● Biology & Biochemistry : 生物学・生化学 | ● Microbiology : 微生物学                      |
| ● Chemistry : 化学                   | ● Molecular Biology & Genetics : 分子生物学・遺伝学 |
| ● Clinical Medicine : 臨床医学         | ● Neuroscience & Behavior : 神経科学・行動学       |
| ● Computer Science : 計算機科学         | ● Pharmacology : 薬理学・毒性学                   |
| ● Economics & Business : 経済学・経営学   | ● Physics : 物理学                            |
| ● Engineering : 工学                 | ● Plant & Animal Science : 植物・動物学          |
| ● Environment/ Ecology : 環境／生態学    | ● Psychiatry/Psychology : 精神医学／心理学         |
| ● Geosciences : 地球科学               | ● Social Sciences—general : 社会科学・一般        |
| ● Immunology : 免疫学                 | ● Space Science : 宇宙科学                     |
| ● Materials Science : 材料科学         | ● *Multidisciplinary : 複合領域                |

Note on Multidisciplinary: Papers from journals that cover many fields, such as *Nature*, *Science*, and the *Proceedings of the National Academy of Sciences*, are assigned to one of the other 21 fields based on citation information.

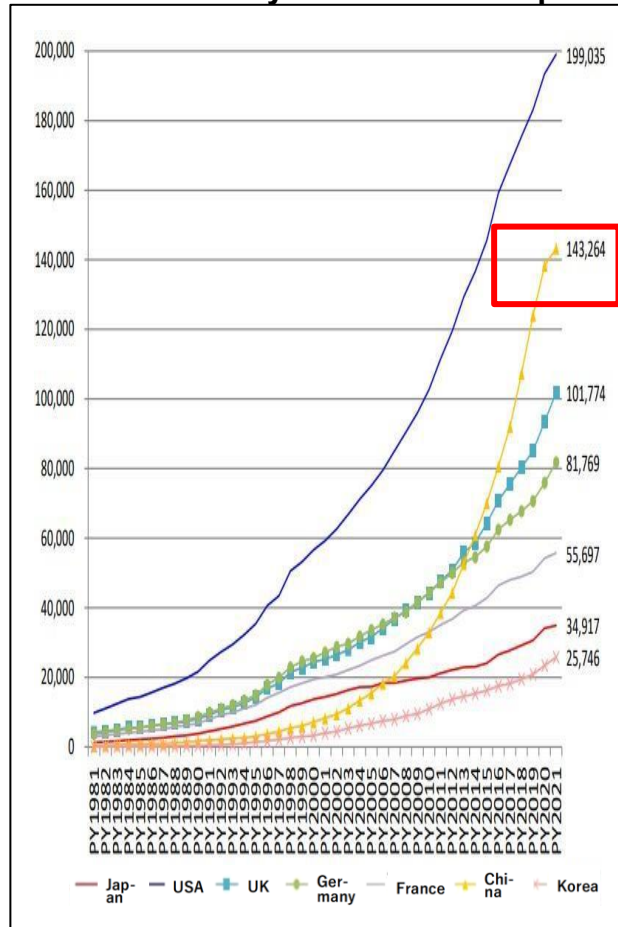
# Trends in China's Internationally Co-authored Papers

The overall increase in the number of papers has led to more international co-authored papers. However, the proportion of these papers among all published papers has remained largely unchanged at 24–26%. Although China's international co-authorship rate is lower than Japan's rate (approximately 36%), China surpasses Japan in the total number of international co-authored papers, ranking second worldwide.

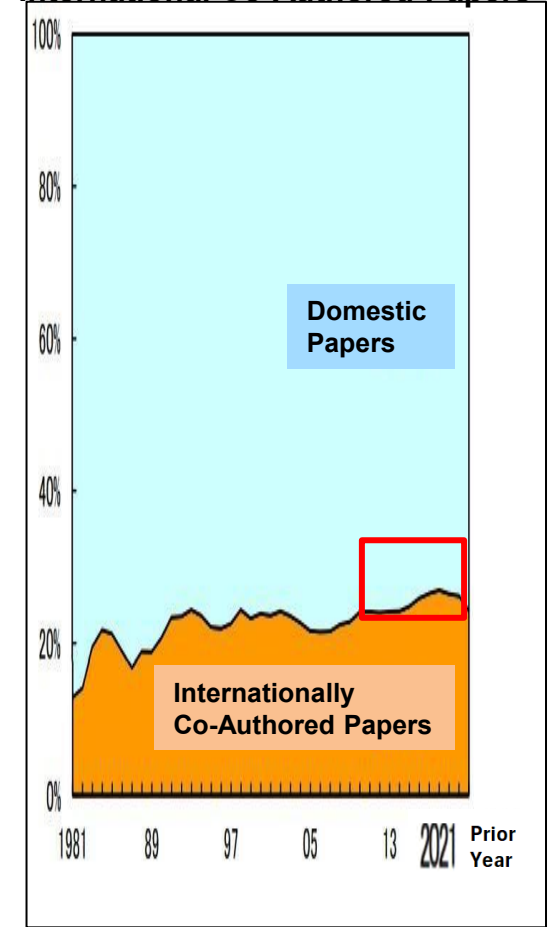
Trends in the Number of Papers



Trends in the Number of Internationally Co-Authored Papers



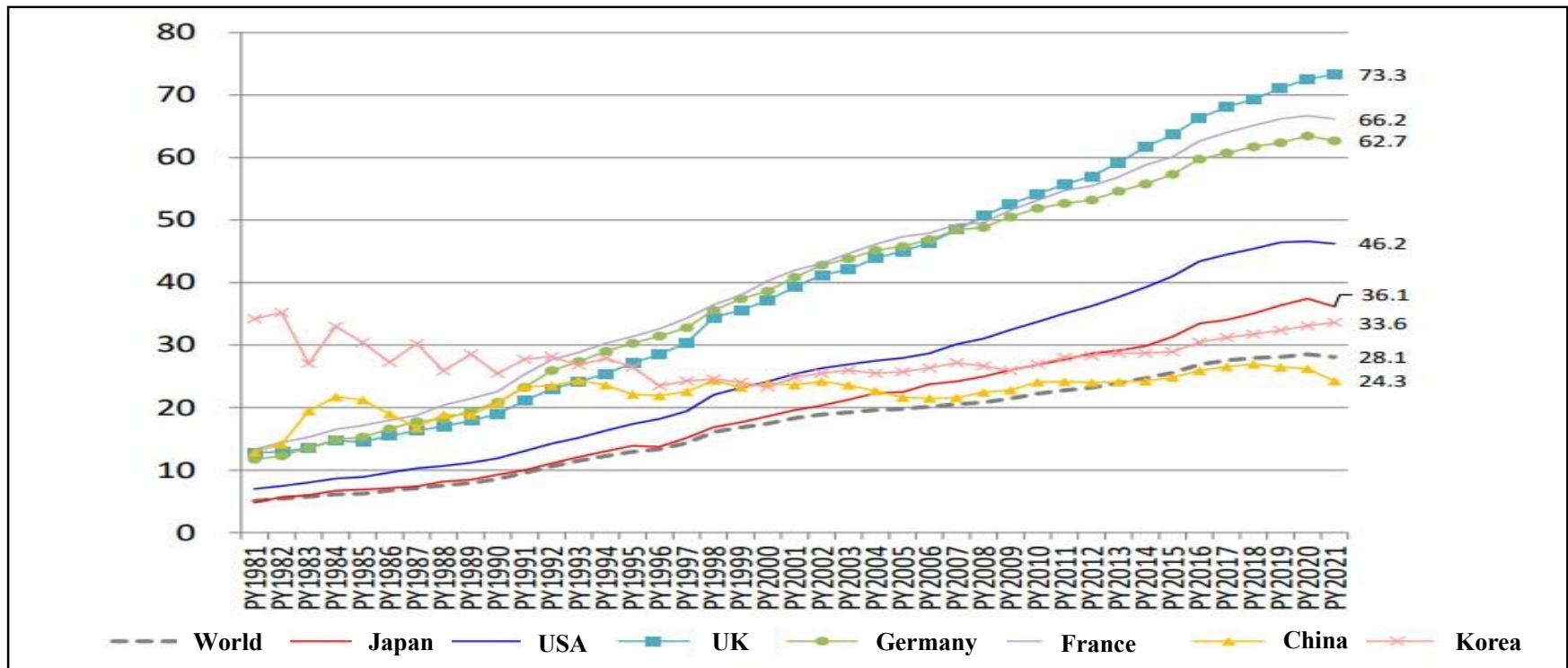
Trends in the Proportion of Internationally Co-Authored Papers



# Trends in China's International Co-authored Paper Rate

- Compared to the increase in total papers from 2020 to 2021, the growth rate of co-authored papers is significantly smaller. China is the only major country showing this trend.
- The proportion of internationally co-authored papers is declining. (※Since all major countries except the UK are experiencing a decline, the impact of the pandemic is presumably significant.)

Trend in International Co-authored Paper Rate (%)



# Changes in the Number of Co-authored Papers Between China and Major Countries

India shows the largest increase in the number of co-authored papers with major countries, followed by the UK, Australia, and Italy. Meanwhile, the increase in co-authored papers with the U.S. and Japan is minimal.

Nation	2013–2017		2018–2022		Growth Multiple
	Number of Co-authored Papers	Rank	Number of Co-authored Papers	Rank	
United States	167,434	1	263,615	1	1.6 times
United Kingdom	36,484	2	84,491	2	2.3 times
Australia	33,028	3	72,322	3	2.2 times
Canada	26,024	4	50,761	4	2.0 times
Germany	25,493	5	48,989	5	1.9 times
Japan	25,484	6	41,701	6	1.6 times
France	15,839	7	28,965	7	1.8 times
Italy	9,174	8	20,203	8	2.2 times
<b>India</b>	6,114	10	19,754	9	<b>3.1 times</b>
Spain	7,711	9	16,256	10	2.1 times



# Changes in the Number of International Co-authored Papers by Field (Top-15 Fields by Paper Count)

Significant growth rates were observed in the following fields: Environmental and Ecological Sciences, Engineering, Agricultural Sciences, Computer Science, Materials Engineering, and Earth Sciences. These fields nearly doubled in size.

ESI Field	2013–2017 Number of International Co-authored Papers	2018–2022 Number of Internationally Co- authored Papers	Percentage Increase
<b>Engineering</b>	<b>46,524</b>	<b>120,185</b>	<b>158.3%</b>
<b>Materials Science</b>	<b>35,195</b>	<b>74,443</b>	<b>111.5%</b>
Chemistry	41,524	69,218	66.7%
Clinical Medicine	31,553	51,636	63.6%
Physics	32,362	45,605	40.9%
<b>Environmental and Ecological Sciences</b>	<b>15,949</b>	<b>44,381</b>	<b>178.3%</b>
Biology and Biochemistry	15,689	24,372	55.3%
<b>Computer Science</b>	<b>18,102</b>	<b>39,982</b>	<b>120.9%</b>
<b>Earth Sciences</b>	<b>20,083</b>	<b>39,800</b>	<b>98.2%</b>
Molecular Biology and Genetics	15,063	18,618	23.6%
Botany and Zoology	14,308	25,470	78%
Mathematics	11,094	19,285	73.8%
<b>Agricultural Sciences</b>	<b>9,383</b>	<b>22,037</b>	<b>134.9%</b>
Pharmacology and Toxicology	6802	11,271	65.7%
Neurology and Psychology	8216	11,658	41.9%

# Changes in China's Field-Specific International Co-authorship Rates (2009–2011 and 2019–2021)

Rates increased in chemistry, materials engineering, physics, computer science, mathematics, and engineering. However, they decreased in environmental and earth sciences, clinical medicine, and basic life sciences.

	All fields	Chemistry	Materials Science	Physics	Computers and Mathematics	Engineering	Environmental and Earth Sciences	Clinical Medicine	Basic Life Sciences
2009–2011	23.7%	13.9%	17.3%	23%	27.7%	25.8%	36.2%	27.8%	29.9%
2019–2021	25.6%	19.7%	24.4%	30%	32.8%	27.1%	34.6%	19%	24.1%
Increase	1.8%	5.8%	7.1%	6.9%	5.1%	1.3%	-1.6%	-8.8%	-5.8%

Source: NISTEP, "Benchmarking of Scientific Research 2023"

# Changes in the Top-6 Fields of Chinese-Coauthored International Papers with Chinese First Authors (2013, 2018, and 2022)

The number of Chinese co-authored international papers with Chinese first authors has significantly increased in the field of electronics, communications, and automatic control. Meanwhile, physics shows a declining trend.

	2013			2018			2022		
	Rank	Number of Papers with Chinese First Authors	Percentage of Total Chinese Co-authored International Papers (%)	Rank	Number of Papers with Chinese First Authors	Percentage of Total Chinese Co-authored International Papers (%)	Rank	Number of Papers with Chinese First Authors	Percentage of Total Chinese Co-authored International Papers (%)
Chemistry	1	3,368	13.9	1	8,193	12.1	2	10,657	13.8
Biology	2	2,817	18.9	2	8,192	12.1	1	11,535	15.5
Physics	3	2,365	16.7	3	5,725	8.4	—	—	—
Clinical Medicine	4	2,009	14.7	4	5,253	7.7	5	8,338	9.4
Materials Science	5	1,423	15.3	5	4,734	7.0	4	8,494	14.9
Computing Technology	6	1,244	25.8	—	—	—	6	8,335	24.6
Electronics, Communications, and Automatic Control	—	—	—	6	4,490	6.6	3	8,890	19.5

Source: Chinese Academy of Sciences Institute of Scientific and Technical Information, "Statistical Data of Chinese S&T Papers" - Data based on papers included in the Science Citation Index (SCI)

# Changes in the Top-6 Fields of Chinese Co-authored International Papers for Which Chinese Authors Are Not First Authors (2013, 2018, and 2022)

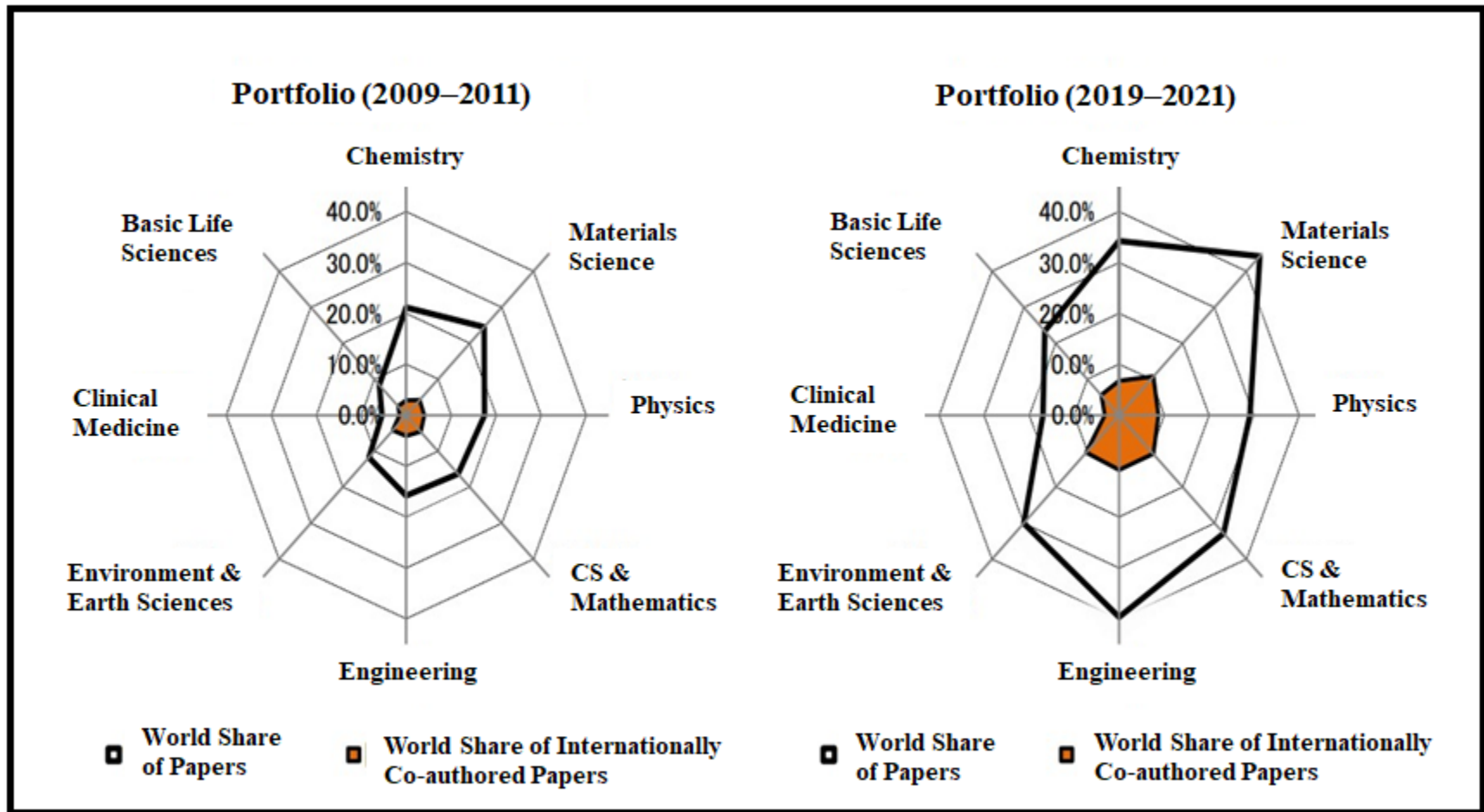
The number of Chinese co-authored international papers for which the first author is not Chinese has increased significantly in environmental science. Clinical medicine also shows an increasing trend, while basic medicine sciences shows a decreasing trend.

	2013			2018			2022		
	Rank	Number of Papers with Chinese First Authors	Percentage of Total Chinese Co-authored International Papers (%)	Rank	Number of Papers with Chinese First Authors	Percentage of Total Chinese Co-authored International Papers (%)	Rank	Number of Papers with Chinese First Authors	Percentage of Total Chinese Co-authored International Papers (%)
Biology	1	2,460	16.5	1	4,258	14.4	1	5,014	6.8
Chemistry	2	2,147	8.9	3	3,572	12.1	3	4,098	5.3
Clinical Medicine	3	1,877	13.8	2	3,933	13.3	2	4,960	5.6
Physics	4	1,614	11.4	4	3,021	10.3	4	2,809	6.4
Basic Medical Sciences	5	1,155	16.0	5	1,659	5.6	—	—	—
Materials Science	6	871	9.3	6	1,618	5.5	5	2,730	4.8
Environmental Science	—	—	—	—	—	—	6	2,623	6.6

Source: Chinese Academy of Sciences Institute of Scientific and Technical Information, "Statistical Data of Chinese S&T Papers" - Data based on papers indexed in the Science Citation Index (SCI)

# Changes in China's Share of Co-Authored Papers by Field

A comparison of data from 2009–2011 and 2019–2021 reveals a significant increase in China's global share of co-authored papers in the fields of materials chemistry, engineering, environmental and earth sciences, computer science, mathematics, and physics.



# Major International Co-authorship Partners of China and Their Share of International Co-authored Papers (%)

The proportion of co-authored papers with the United States has increased in recent years. However, it decreased by 5 percentage points between 2017–2019 and 2019–2021.

Table 1: Major International Co-authorship Partner Countries/Regions (2009–2011, %)

Field (China)	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
All Fields	USA: 43.7%	Japan: 10.6%	UK: 9.6%	Canada: 7.8%	Australia: 7.7%	Germany: 7.7%	France: 5.0%	S. Korea: 4.6%	Singapore: 4.5%	Taiwan: 3.4%
Chemistry	USA: 35.1%	Japan: 11.9%	Germany: 8.1%	UK: 7.0%	Australia: 6.4%	Canada: 6.1%	France: 5.5%	Singapore: 5.1%	S. Korea: 4.9%	Taiwan: 2.9%
Materials Science	USA: 32.5%	Japan: 14.7%	Australia: 8.9%	Germany: 8.5%	UK: 7.7%	Singapore: 6.2%	S. Korea: 5.9%	Canada: 5.0%	France: 4.7%	Sweden: 2.4%
Physics	USA: 42.7%	Germany: 15.9%	Japan: 14.1%	UK: 10.4%	France: 9.8%	S. Korea: 7.4%	Australia: 6.5%	Russia: 6.4%	Canada: 6.3%	Singapore: 6.1%
Comp. Sci. & Math	USA: 38.6%	Canada: 9.5%	UK: 8.3%	Australia: 8.0%	Japan: 6.3%	Singapore: 5.7%	Taiwan: 5.6%	France: 5.6%	S. Korea: 5.0%	Germany: 4.2%
Engineering	USA: 33.7%	UK: 14.8%	Australia: 9.8%	Canada: 9.6%	Japan: 8.3%	Singapore: 7.7%	France: 3.8%	S. Korea: 3.7%	Taiwan: 3.5%	Germany: 3.3%
Env. & Earth Sci.	USA: 46.7%	Canada: 10.8%	Japan: 10.4%	UK: 9.7%	Australia: 9.4%	Germany: 8.6%	France: 4.9%	Taiwan: 3.4%	Netherlands: 3.1%	S. Korea: 2.8%
Clinical Medicine	USA: 57.0%	UK: 10.0%	Japan: 9.9%	Australia: 8.9%	Canada: 7.5%	Germany: 6.6%	S. Korea: 4.2%	France: 3.9%	Singapore: 3.8%	Taiwan: 3.6%
Basic Life Sci.	USA: 51.3%	Japan: 10.1%	UK: 8.4%	Canada: 7.9%	Germany: 6.4%	Australia: 6.2%	S. Korea: 3.6%	France: 3.4%	Netherlands: 2.5%	Singapore: 2.4%

Table 2: Major International Co-authorship Partner Countries/Regions (2019–2021, %)

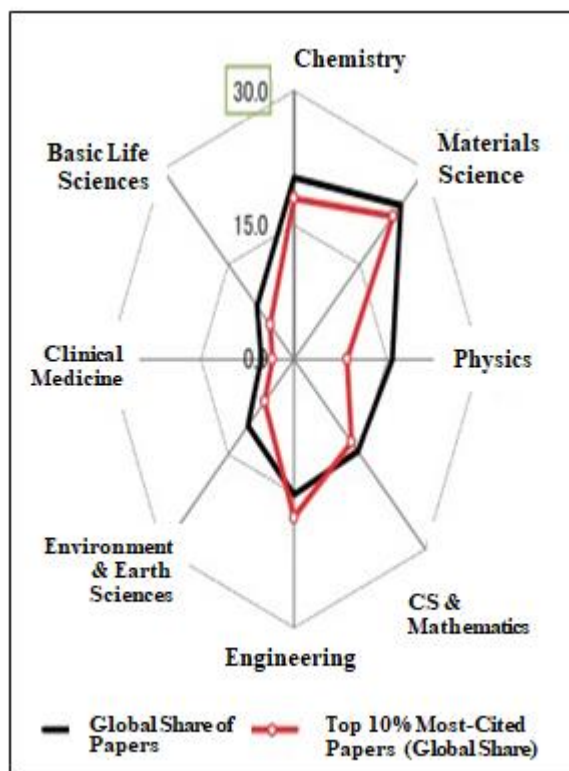
Field (China)	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
All Fields	USA: 39.2%	UK: 12.5%	Australia: 10.7%	Canada: 7.5%	Germany: 7.5%	Japan: 6.3%	France: 4.5%	Singapore: 4.4%	S. Korea: 4.0%	Pakistan: 3.8%
Chemistry	USA: 32.6%	UK: 9.1%	Australia: 8.9%	Germany: 7.9%	Japan: 7.4%	Canada: 6.4%	Singapore: 4.9%	S. Korea: 4.5%	France: 4.2%	Pakistan: 3.7%
Materials Science	USA: 33.5%	Australia: 12.7%	UK: 10.1%	Germany: 7.4%	Japan: 7.4%	Singapore: 6.9%	Canada: 5.2%	S. Korea: 4.6%	France: 3.2%	Taiwan: 2.9%
Physics	USA: 42.1%	Germany: 17.8%	UK: 16.6%	Japan: 11.8%	France: 10.8%	Italy: 9.3%	Australia: 8.9%	Russia: 8.3%	Spain: 7.3%	Canada: 6.9%
Comp. Sci. & Math	USA: 34.6%	UK: 12.1%	Australia: 10.4%	Canada: 9.0%	Singapore: 5.5%	Taiwan: 4.3%	Japan: 4.3%	S. Korea: 4.2%	Pakistan: 4.0%	France: 3.8%
Engineering	USA: 29.8%	UK: 15.9%	Australia: 11.5%	Canada: 8.0%	Singapore: 5.6%	Japan: 4.8%	Germany: 3.7%	Pakistan: 3.3%	S. Korea: 3.3%	France: 3.1%
Env. & Earth Sci.	USA: 38.8%	Australia: 12.4%	UK: 12.3%	Canada: 9.0%	Germany: 8.4%	Japan: 5.3%	France: 4.8%	Pakistan: 4.5%	Netherlands: 3.7%	S. Korea: 3.1%
Clinical Medicine	USA: 57.3%	UK: 14.8%	Australia: 11.6%	Germany: 8.9%	Canada: 8.8%	Japan: 7.4%	Italy: 5.9%	Netherlands: 4.9%	France: 4.9%	Taiwan: 4.8%
Basic Life Sci.	USA: 47.1%	UK: 9.7%	Australia: 8.8%	Canada: 7.2%	Germany: 7.2%	Japan: 5.4%	Pakistan: 4.9%	France: 4.0%	S. Korea: 3.3%	Netherlands: 3.0%

	2007–2009	2009–2011	2017–2019	2019–2021
Percentage of Co-authored Papers with the U.S. (%)	40.8	43.7	44.5	39.2
Number of co-authored papers with China (papers)	-	-	124,222	143,264
Number of co-authored papers with the United States (papers)	-	-	55,279	56,159

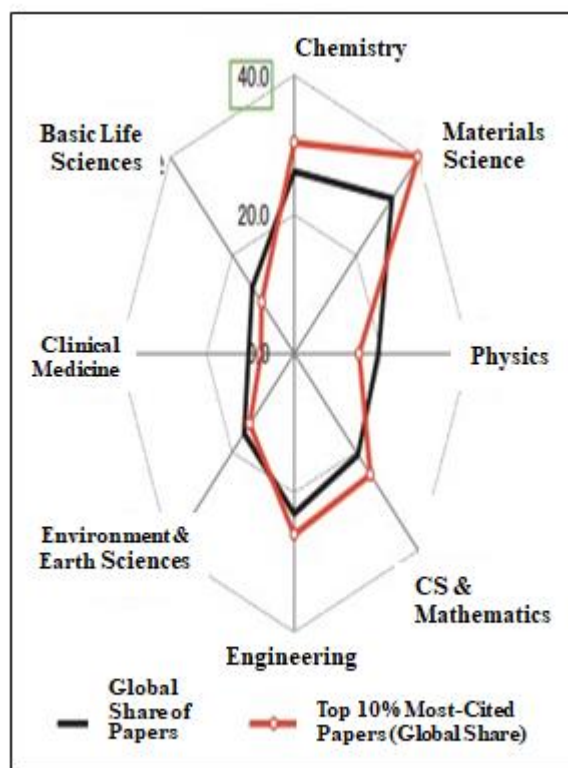
# Changes in China's Share of Papers by Field (Total and Top 10%)

China has increased its global share of top 10% most-cited papers in all fields, particularly in chemistry, engineering, materials science, computer science, and mathematics.

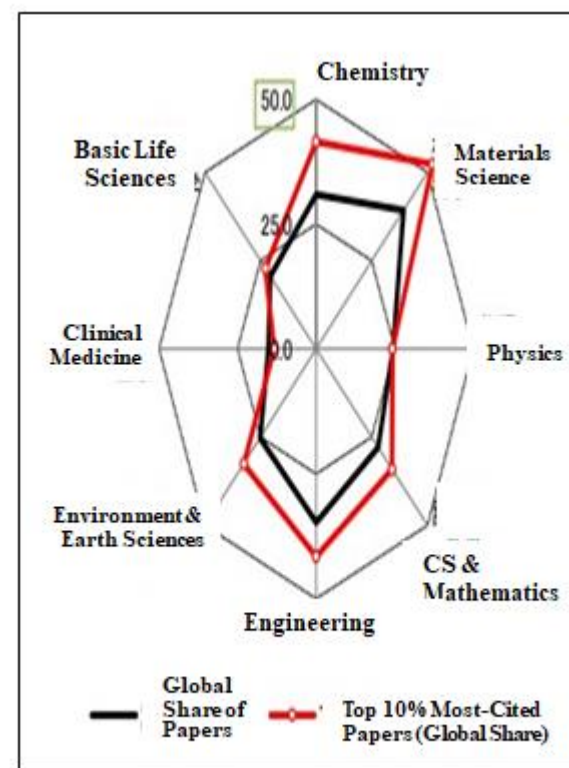
2010-2012



2014-2016



2019-2021

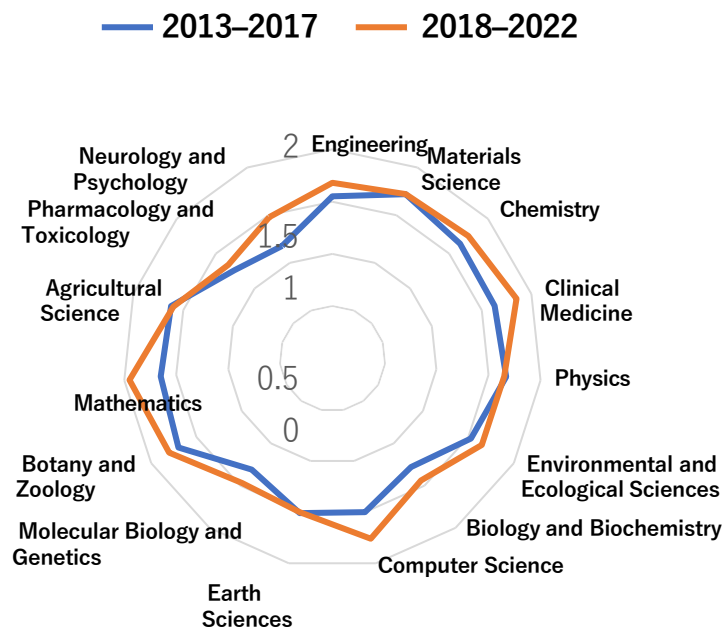


# Relative Citation Impact of International Co-Authored Papers by Field

Citation impact is increasing in the fields of neuroscience and psychology, mathematics, computer science, clinical medicine, molecular biology, and genetics.

Relative Citation Impact (CNCI): The number of citations a paper receives divided by the average number of citations received by papers in the same field and publication year. With 1 as the baseline, the level is determined by whether the value exceeds 1.

### Changes in the relative citation impact of international co-authored papers by field



Source: Clarivate China, "Current Status of China's International Scientific Research Collaboration 2023"

# Hot Topics in Large-Scale International Collaborative Research with Over 100 Authors

From 2013 to 2022, Chinese scholars contributed to 5,757 large-scale international collaborative research papers with over 100 authors each, according to Web of Science (WoS). Of these, 76.6% were in physics, primarily focusing on particle physics, quantum field theory, astronomy and astrophysics, and nuclear physics.

WoS Field	Number of Papers
Physics, Quantum Field Theory	3,147
Astronomy and Astrophysics	1,890
Physics, Nuclear Physics	1,009
Physics, Interdisciplinary	768
Facilities and Equipment	251
Physics, Liquids, and Plasmas	218
Genetics and Heredity	166
Nuclear Chemistry and Technology	161
Public Works, Environment, and Occupational Health	73
Oncology	48

WoS Citation Topics	Number of Papers
5.9.19 Standard Model	2,381
5.9.428 Heavy Ion Collisions	744
5.9.73 Nucleon	652
5.200.58 Tokamak-type	383
5.9.398 Neutrino	220
5.9.746 Gravitational Waves	150
1.189.455 Genome-wide Association Studies	103
1.175.1151 Gas Detectors	62
5.20.825 Cosmic Rays	61
5.20.156 X-rays	51

# Summary 1

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- The growth rate of international papers co-authored by Chinese scholars slowed significantly in 2021. Despite a steady increase in the proportion of China–U.S. co-authored papers in recent years, that share decreased by 5% during 2019–2021 compared to 2017–2019. (This decline is likely due not only to the impact of the pandemic, but also to factors such as U.S.–China friction.)
- Between 2020 and 2021, the growth rate of co-authored papers was considerably smaller than the overall increase in published papers. (China was the only major country experiencing this.)
- The proportion of international co-authored papers is declining. However, since all major countries except the UK are experiencing this decline, it is likely primarily due to the impact of the pandemic.

# Summary 2

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- As the number of papers increases, so does the number of co-authored papers in China. However, China's proportion of international co-authored papers stands at 24.3%, which is lower than that of other countries, such as the UK (73.3%), France (66.2%), Germany (62.7%), the U.S. (46.2%), and Japan (36.1%). Over the past decade, this proportion has varied between 24% and 26%.
- Among China's international co-authored papers published from 2013 to 2022, those in the fields of engineering, chemistry, materials science, clinical medicine, and physics accounted for over 60% of the total.
- The growth rate of international co-authored papers in environmental and ecological sciences, engineering, agricultural sciences, computer science, materials engineering, and earth sciences nearly doubled between 2013–2017 and 2018–2022.
- In terms of relative citation impact, which measures quality, notable increases were seen between 2013–2017 and 2018–2022 in psychiatry and psychology, mathematics, clinical medicine, and computer science.

## 2. Temporal Changes in Human Mobility



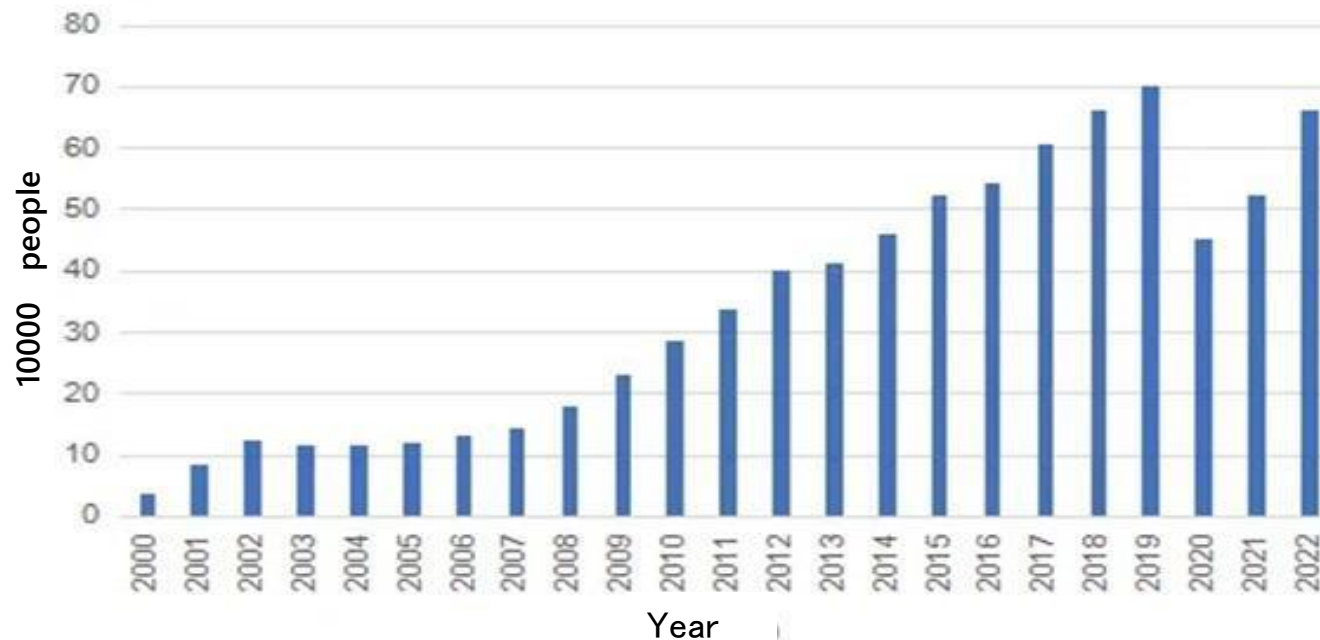
## 2.1 International Students

Referenced data from CCG, "China Study Abroad Development Report," "Study Abroad White Paper," Statista, IEE, Ministry of Education data, etc.

# Current Status of China's Study-Abroad Development

- China is the largest source of international students. India's numbers are rapidly increasing, but they are still about half of China's. (2021 figures: China: 1,021,000; India: 508,000).
- China's enthusiasm for studying abroad remains high. Although the number temporarily decreased due to the pandemic, it has begun to increase again. (2019: 703,500 students, 6.7% growth rate; 2021: 523,700 students, 0.2% growth rate; 2022: 661,200 students.)

Changes in the Number of Chinese Students Studying Abroad (2000–2022)



Source: China Study Abroad Development Report 2023-2024, Ministry of Education educational statistics, etc.

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# Changes in Top Destination Countries for Chinese International Students

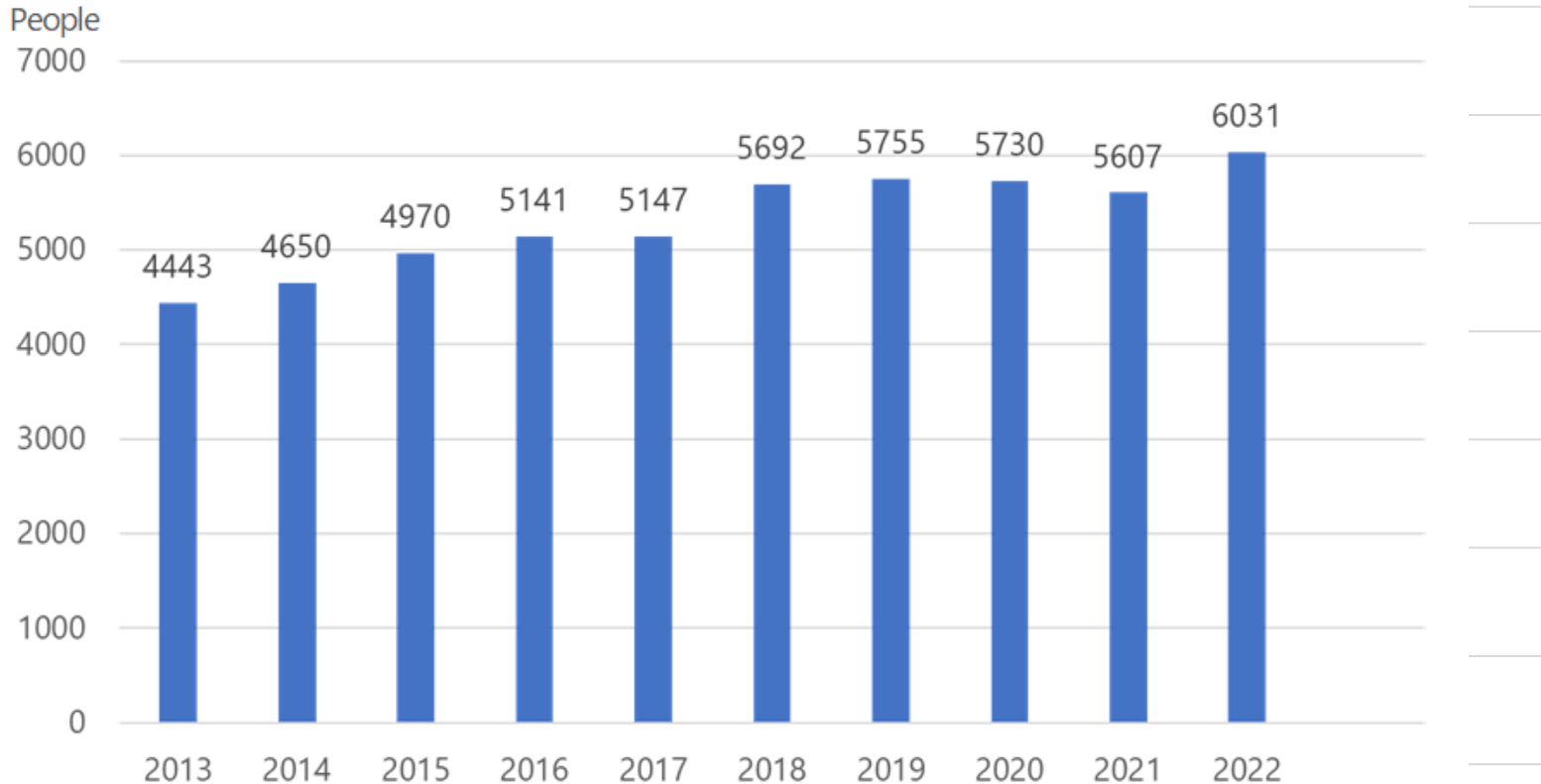
- Ten years ago, the U.S. and the UK were the top two choices. Students who selected these two countries accounted for over 60% of the total. In recent years, however, the balance among countries has evened out. Notably, Asian countries such as South Korea and Malaysia have also entered the top tier.
- The top 10 countries in 2021 were the United States, the United Kingdom, Australia, Japan, Canada, South Korea, Hong Kong, Malaysia, Germany, and Macau (see the chart on the right).
  - The United States accounted for about 28%; the United Kingdom and Australia for 14% each; Japan and Canada for 10% each; and South Korea for about 6%.
- The top 10 countries in 2017 were the United States, the United Kingdom, Australia, Canada, Germany, Japan, France, Hong Kong, New Zealand, and Singapore.
- The top 11 countries in 2012 were the United States, the United Kingdom, Australia, Canada, Hong Kong, Japan, France, Germany, the Netherlands, Singapore, and South Korea.
  - The United States accounted for about 48%, the United Kingdom for 14%, Australia for 10%, and Canada for 6%.

	Study Abroad Destinations	2021/2022 Number of Chinese Students
1	United States	290,086
2	United Kingdom	151,690
3	Australia	141,011
4	Japan	103,882
5	Canada	100,075
6	South Korea	67,348
7	Hong Kong	46,662
8	Malaysia	38,714
9	Germany	38,386
10	Macau	27,219
11	France	23,450

Source: CCG, "China Study Abroad Development Report 2023-2024"; IEE, "Project Atlas 2022."(Due to differences in data collection periods and methods among countries, statistics may be incomplete.)

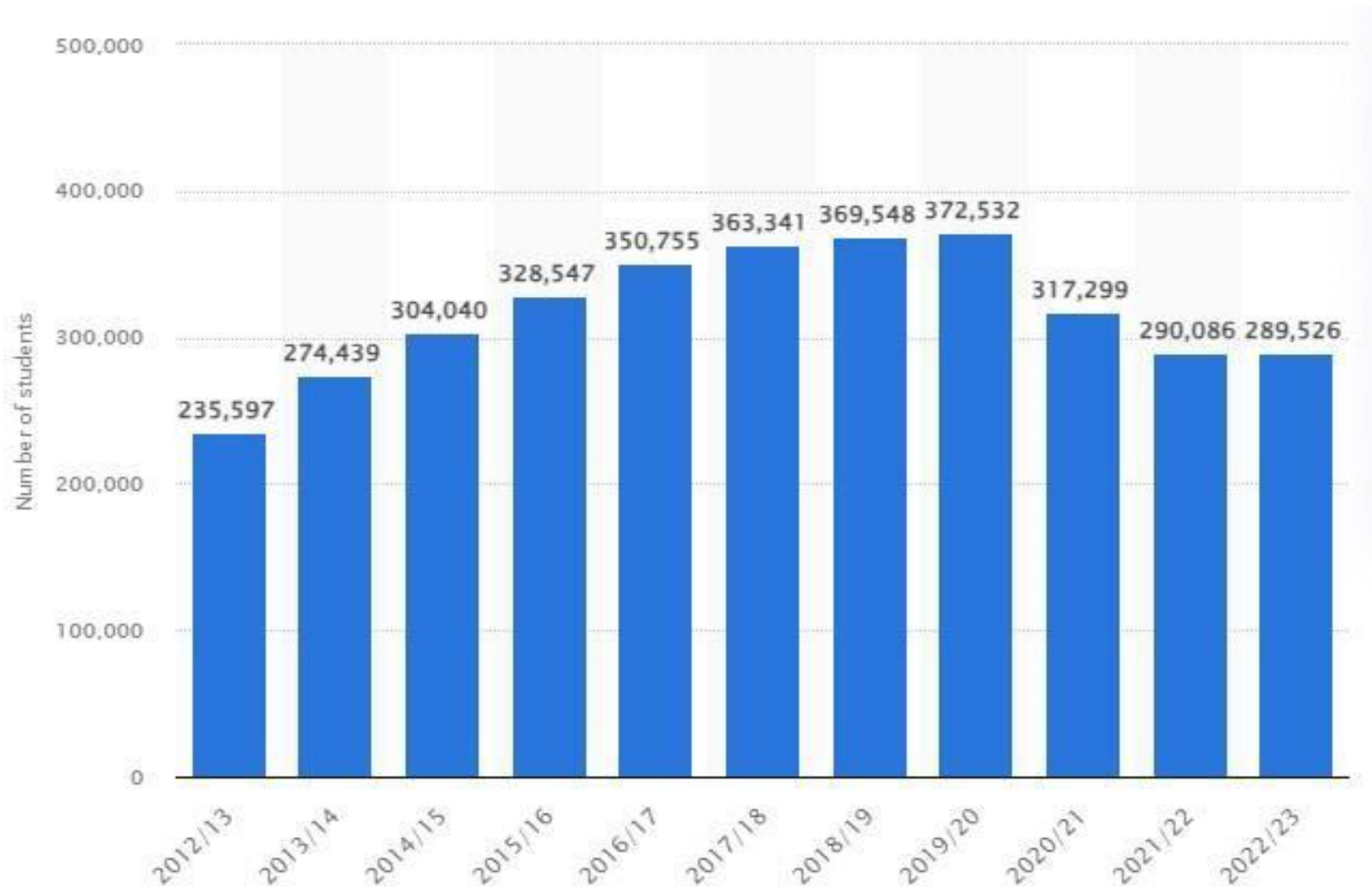
# Chinese Doctoral Graduates in Science and Technology Fields in the United States: Overall Trends

Over the past decade, the number of Chinese individuals earning doctoral degrees in the United States has steadily increased.



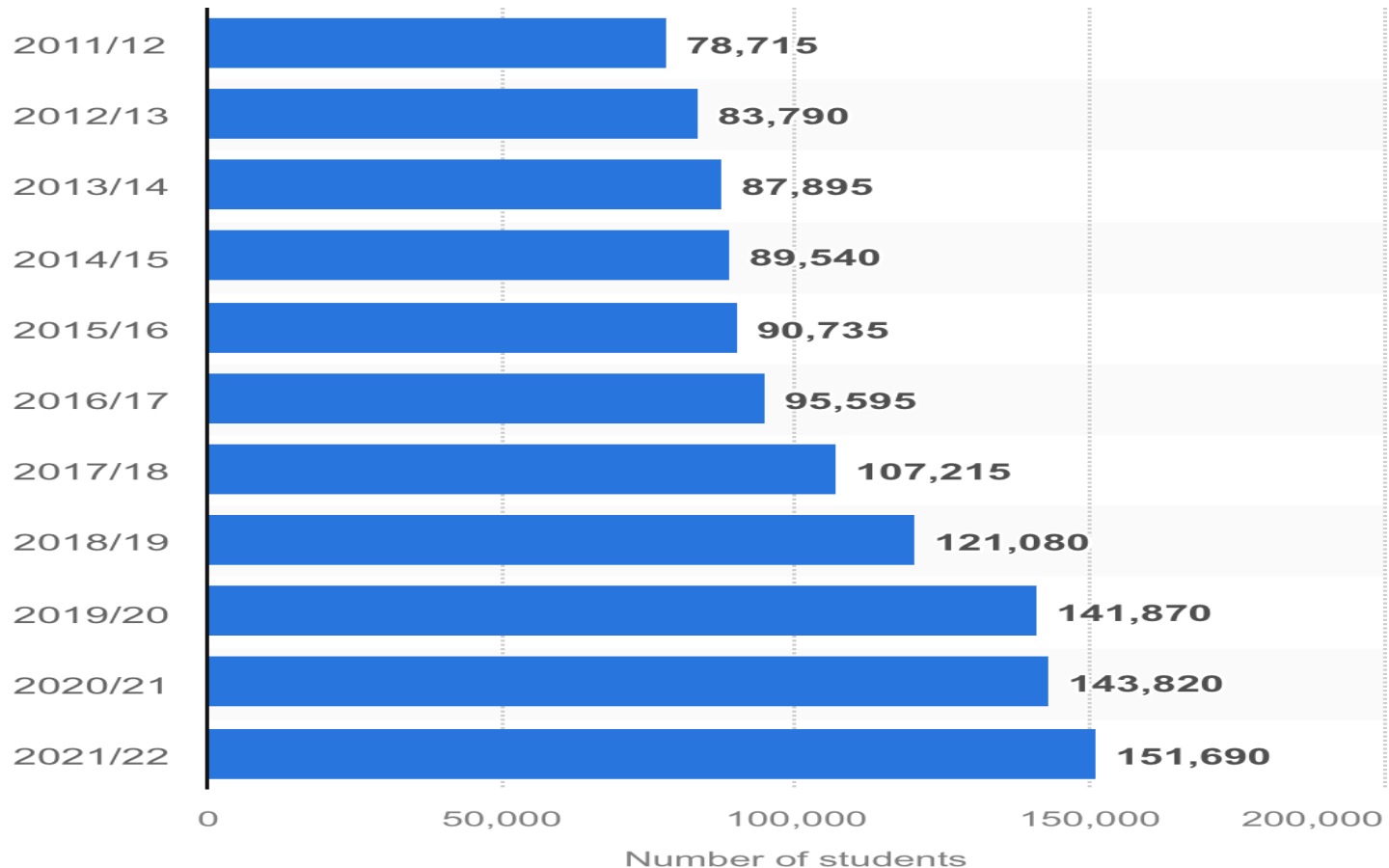
Source: NSF, Survey of Earned Doctorates  
\*Science and technology fields refer to science and engineering

## Trends in the Number of Chinese International Students: the United States



Source: Statista 2024 - Number of college and university students from China in the United States from academic year 2012/13 to 2022/23

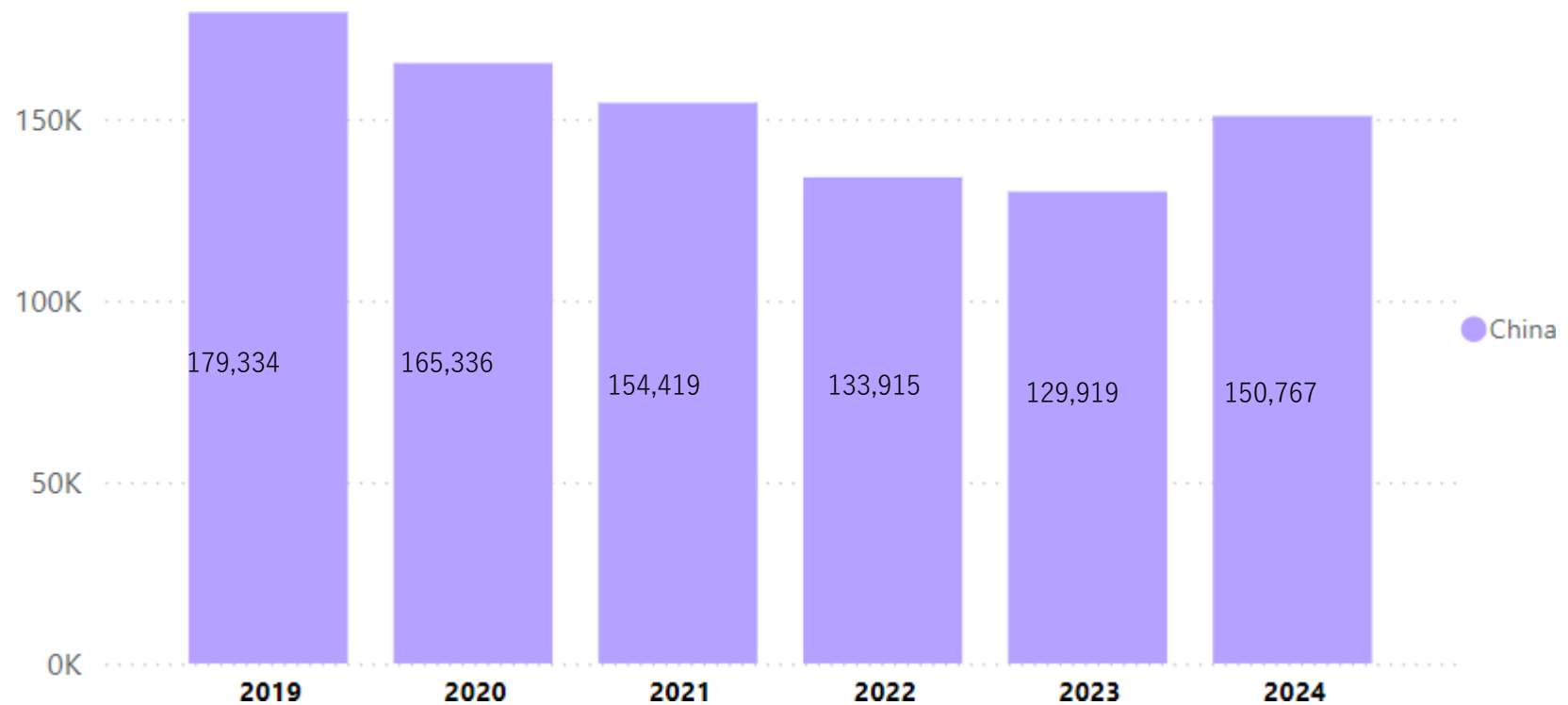
# Trends in the Number of Chinese International Students: the UK



Source: Statista 2024 - Number of students from China studying in the United Kingdom from academic year 2011/12 to 2021/22

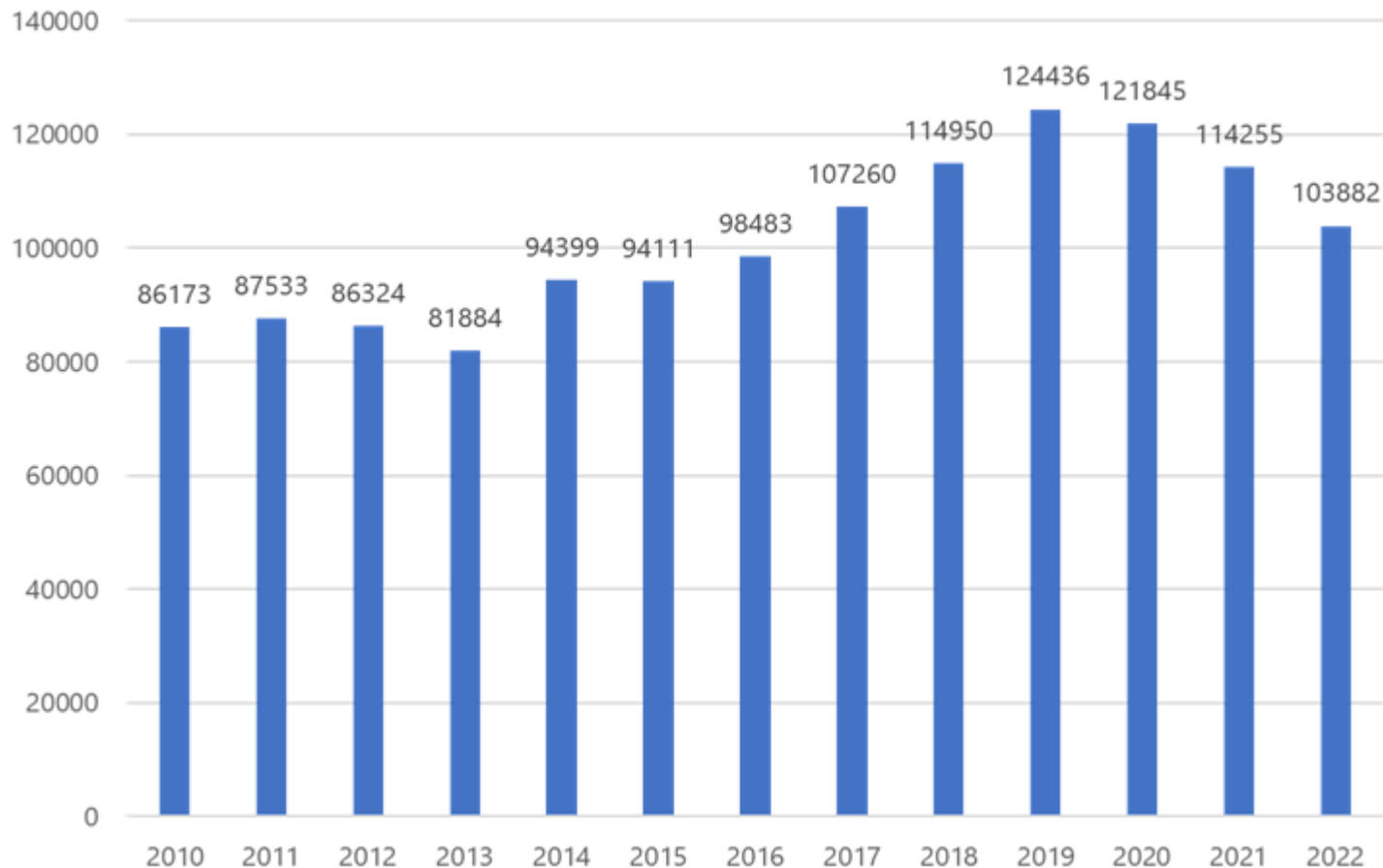
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# Trends in the Number of Chinese International Students: Australia



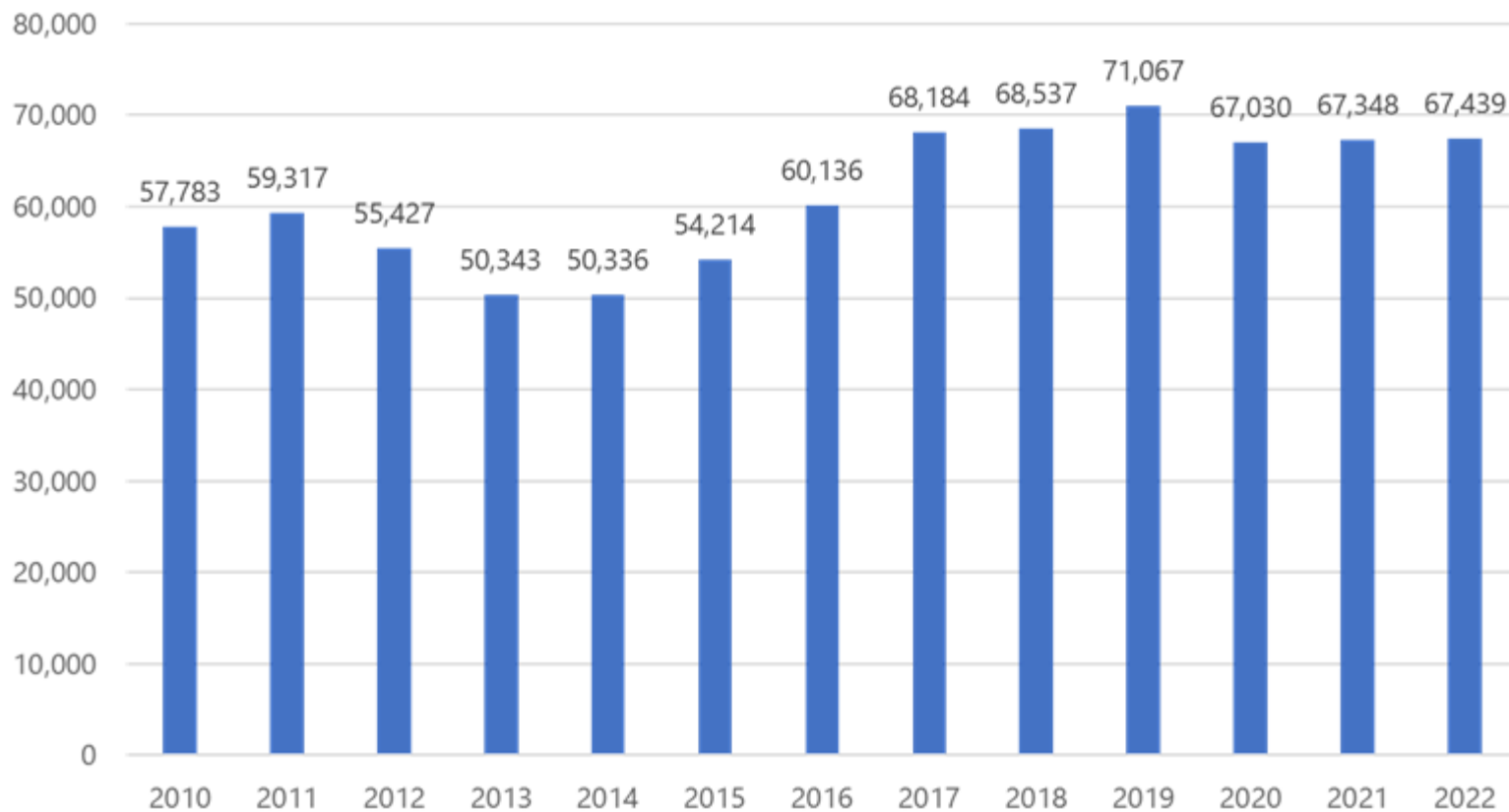
Source: [Australian Department of Education](#)

# Trends in the Number of Chinese International Students: Japan



Source: JASSO, "Survey on the Status of Foreign Students Enrolled in Japan"

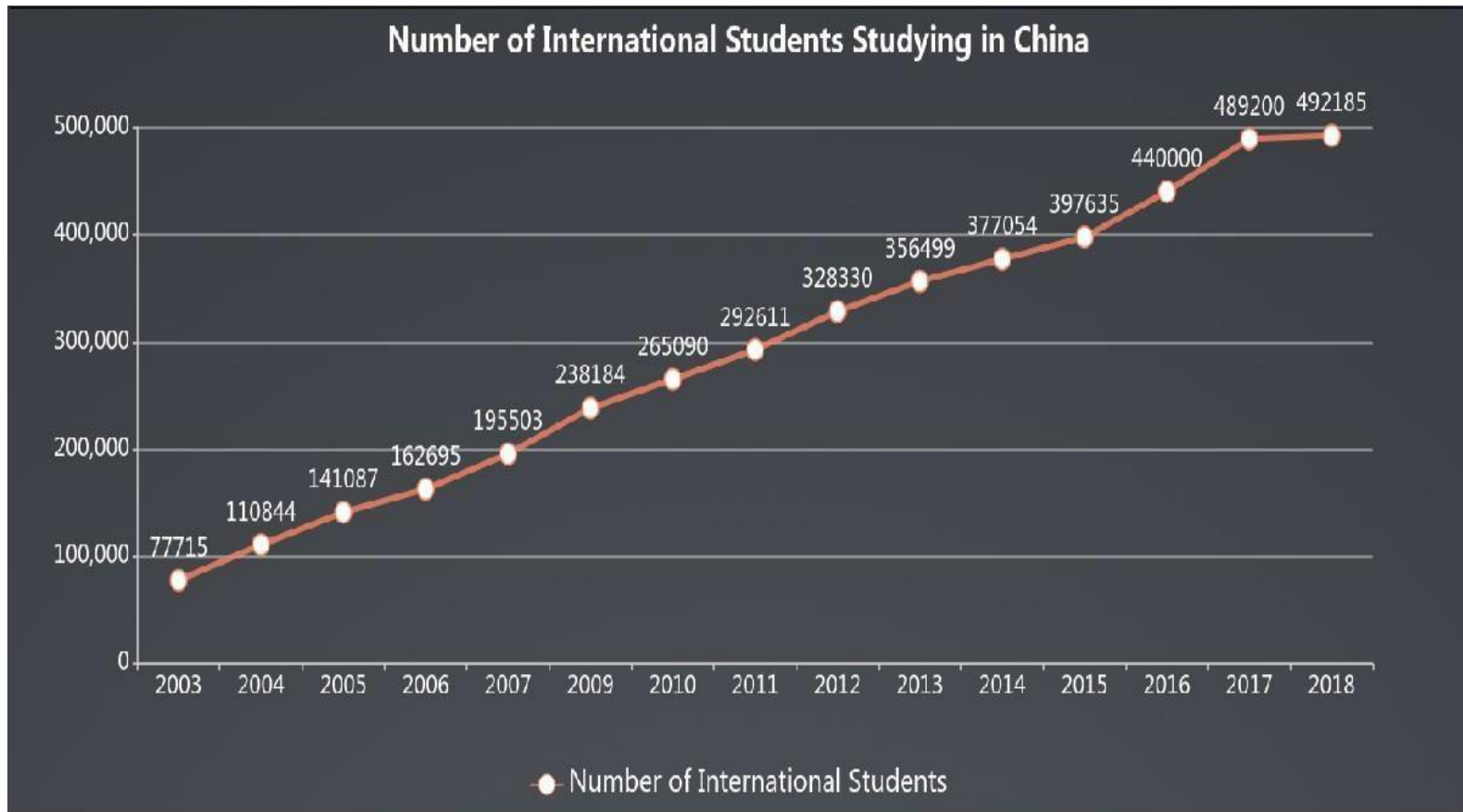
## Trends in the Number of Chinese International Students: South Korea



Source: Korea Institute of Curriculum and Evaluation

# Number of International Students in China

The number of international students in China has not been publicly disclosed since 2018. However, it showed an upward trend until that year. Some overseas media outlets reported that the number of international students dropped to approximately 390,000 in 2019, though this figure is uncertain.



Source: Ministry of Education of China

# Changes in the Countries of Origin of International Students in China (2011, 2018)

2011			2018		
Rank	Country	Number of Students	Rank	Country	Number of Students
1	South Korea	62,442	1	South Korea	50,600
2	United States	23,292	2	Thailand	28,608
3	Japan	17,961	3	Pakistan	28,023
4	Thailand	14,145	4	India	23,198
5	Vietnam	13,549	5	United States	20,996
6	Russia	13,340	6	Russia	19,239
7	Indonesia	10,957	7	Indonesia	15,050
8	India	9,370	8	Laos	14,645
9	Pakistan	8,516	9	Japan	14,230
10	Kazakhstan	8,287	10	Kazakhstan	11,784
			11	Vietnam	11,299
			12	Bangladesh	10,735
			13	France	10,695
			14	Mongolia	10,158
			15	Malaysia	9,479

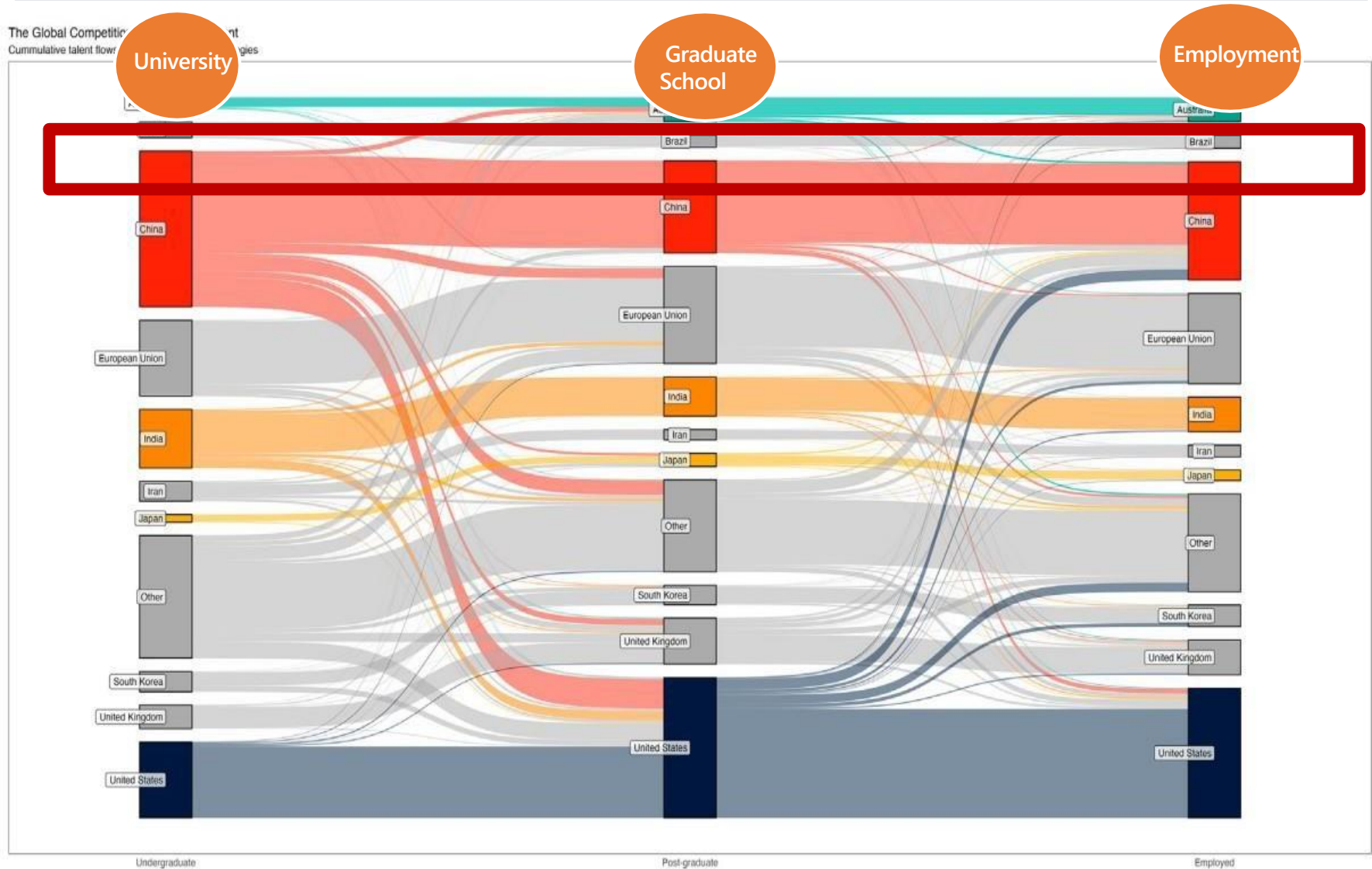
- Comparing data from 2011 and 2018, students from South Korea were the largest group in both years, though the actual number decreased.
- The number of students from Thailand, Pakistan, and India has increased significantly.
- In 2011, the top countries of origin were the United States, Japan, Thailand, and Vietnam. However, in 2018, those countries were Thailand, Pakistan, India, the United States, and Russia.

Source: Ministry of Education of China

## 2.2 Researchers

ASPI's Critical Technology Tracker: The global race for future power

The most common pattern for researchers in core technology fields (see p. 35) is to graduate from a Chinese university, pursue graduate studies in another country (primarily the U.S. or the E.U.), and then return to China for employment.



# Post-Graduation Mobility of Chinese Researchers

## ■ Mobility by Five Major Core Technologies

Field	Core Technology	University	Graduate School	Employment	(Explanation)
AI and Communications	Advanced Integrated Circuits, Design, and Manufacturing	China	United States	China	China actively recruits researchers from other countries for employment.
Quantum	Quantum Computing	China	United States	United States	Approximately 50% of Chinese university graduates choose to attend graduate school in the U.S., the UK, the EU, or Canada. During this period, China recruits researchers both domestically and internationally.
	Quantum Encryption	China	EU	China	About 50% of Chinese university graduates choose to attend graduate school in Canada, the U.S., Singapore, or the UK. However, the number of researchers recruited at the employment stage far exceeds the number of international students.
Advanced Materials & Manufacturing	Mechanical Engineering	China	United States	China	Some Chinese university graduates choose to study abroad in the U.S. or the UK. Individuals holding degrees from these countries are often hired at the employment stage.
	Smart Materials	China	China	China	Many students choose to study abroad after graduating from Chinese universities, opting for the U.S., the UK, the EU, and Singapore. China has the largest number of researchers in this field worldwide.

Source: ASPI's Critical Technology Tracker: The global race for future power

※The fields listed in the table above correspond to the 44 core technologies defined in the aforementioned report (see p. 35).

# 44 Core Technologies

Technology	Lead country	Technology monopoly risk
<b>Advanced materials and manufacturing</b>		
1. Nanoscale materials and manufacturing	China	high
2. Coatings	China	high
3. Smart materials	China	medium
4. Advanced composite materials	China	medium
5. Novel metamaterials	China	medium
6. High-specification machining processes	China	medium
7. Advanced explosives and energetic materials	China	medium
8. Critical minerals extraction and processing	China	low
9. Advanced magnets and superconductors	China	low
10. Advanced protection	China	low
11. Continuous flow chemical synthesis	China	low
12. Additive manufacturing (incl. 3D printing)	China	low
<b>Artificial intelligence, computing and communications</b>		
13. Advanced radiofrequency communications (incl. 5G and 6G)	China	high
14. Advanced optical communications	China	medium
15. Artificial intelligence (AI) algorithms and hardware accelerators	China	medium
16. Distributed ledgers	China	medium
17. Advanced data analytics	China	medium
18. Machine learning (incl. neural networks and deep learning)	China	low
19. Protective cybersecurity technologies	China	low
20. High performance computing	USA	low
21. Advanced integrated circuit design and fabrication	USA	low
22. Natural language processing (incl. speech and text recognition and analysis)	USA	low
<b>Energy and environment</b>		
23. Hydrogen and ammonia for power	China	high
24. Supercapacitors	China	high
25. Electric batteries	China	high
26. Photovoltaics	China	medium
27. Nuclear waste management and recycling	China	medium
28. Directed energy technologies	China	medium
29. Biofuels	China	low
30. Nuclear energy	China	low
<b>Quantum</b>		
31. Quantum computing	USA	medium
32. Post-quantum cryptography	China	low
33. Quantum communications (incl. quantum key distribution)	China	low
34. Quantum sensors	China	low
<b>Biotechnology, gene technology and vaccines</b>		
35. Synthetic biology	China	high
36. Biological manufacturing	China	medium
37. Vaccines and medical countermeasures	USA	medium
<b>Sensing, timing and navigation</b>		
38. Photonic sensors	China	high
<b>Defence, space, robotics and transportation</b>		
39. Advanced aircraft engines (incl. hypersonics)	China	medium
40. Drones, swarming and collaborative robots	China	medium
41. Small satellites	USA	low
42. Autonomous systems operation technology	China	low
43. Advanced robotics	China	low
44. Space launch systems	USA	low

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Topic Research

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