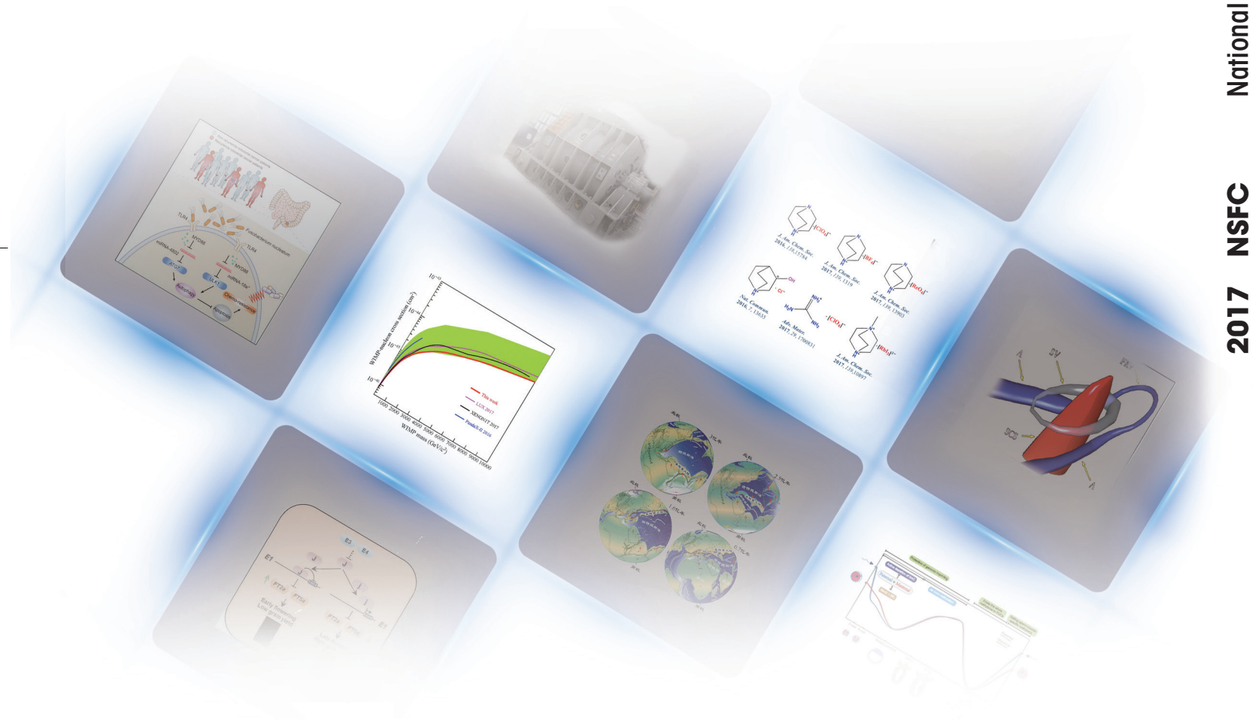

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National Natural Science Foundation of China

2017 NSFC

NSFC

ANNUAL REPORT 2017

National Natural Science Foundation of China

Preface

In 2017, under the robust leadership of the CPC Central Committee with General Secretary Xi Jinping as its core, the National Natural Science Foundation of China (NSFC) studied, advocated and thoroughly implemented the spirit of the 19th CPC National Congress, and put into practice the strategies of the Central Committee and the State Council. In line with the requirement to take a holistic approach to carry out the five-sphere integrated plan and the four-pronged comprehensive strategy, NSFC adhered to the principles of innovative, coordinated, green, open, and shared development, gave substance to the spirit of the National S&T Innovation Conference and made overall plans about program funding and management. NSFC provided strong support to basic research and exploration in scientific frontiers, talent training, research team building, multi-disciplinary studies and bolstering source innovation capacity.

Yang Wei, President
National Natural Science Foundation of China

Study, advocate and put into practice the spirit of the 19th CPC National Congress and fully exercise stricter governance over Party members. The CPC Committee of NSFC required all staff to align their thinking with the spirit of the 19th Congress, focus on the tasks outlined in the Congress and guide their works at NSFC with the spirit and Xi Jinping Thought on Socialism with Chinese Characteristics in a New Era. The Committee adjusted itself in line with the CPC central inspection team's requirements and made a work schedule against the identified issues and related ones in order to make sure everyone of them is accounted for. A steering group had been set up to enhance the Party's leadership over NSFC and improve the Party building. The Committee improved the regulative document system to institutionalize Party building works. It also held meetings to discuss clean governance of the Party, with accountable tasks set out to continue improving work ethics among the Party members. All CPC branches at NSFC implement the Party's requirement to gain a good command of the Party Constitution, Party regulations, and related major policy addresses and to meet the Party standards. As a result, new and positive results have been achieved at the base level of the Party.

Make overall reform plans about funding and deepening management and align with major national decisions and strategic demand. In order to give substance to the message conveyed

in the National S&T Innovation Conference, NSFC made an "NSFC's assignment plan for major tasks in line with the spirit of the Conference". Instructed by the CPC Central Committee and the State Council, NSFC shores up support for the artificial intelligence and other sectors, and devotes great energy to support basic research in education sciences. NSFC, in a holistic manner, implements the funding plans and improves its management to ramp up funding for key and major programs. Programs and funds are now better managed to meet pre-set performance standards, in keeping with the governance reform goals of streamlining administration and improving service.

Keep eyes on scientific frontiers, build a better science base for the country, further coordinate development of scientific fronts and cultivate major original achievement. NSFC encourages the scientific communities to conduct innovative research to push for growth in all fronts. NSFC directs more attention to nationally preferred sectors and encourages and organizes top scholars to engage in systemic innovative research, with breakthroughs already achieved in several fronts. With support from NSFC and other scientific programs, remarkable growth has been registered in different scientific fields. In 2017, 64.54% of SCI papers by Chinese scholars received funding from NSFC. In addition, NSFC set up a joint fund for space and satellite research with the Chinese Academy of Sciences (CAS) in order to support frontier studies in that regard.

Focus on talent team building and training young people. Funding scheme for talent has been further bolstered to help with the development of talented people. Single program funding in the Young Scientists Fund has been increased to 230,000 yuan, 18.10% more than that in 2016. Resource allocation approach has been improved for the Excellent Young Scientist Fund and Distinguished Young Scientist Fund to balance support for talented young people in different fields. Entrusted by the Organization Department of the CPC Central Committee, NSFC has been reviewing young talent programs under the Recruitment Program of Global Experts and is collaborating with the Office for the Central Coordination Group for Talent Work to set up studios for distinguished talented scientists under the "Ten Thousand Talents Plan".

Aim at improving multi-disciplinary research and innovation. NSFC attaches importance to inter-disciplinary research and brings together high-end talents to shore up high ground of scientific research. Basic Science Center Programs continue to be carried out. Four such programs have been selected, up from three. By pooling top scholars and providing sustainable support to them, NSFC has seen further multi-disciplinary integration as well as the rise of several academic high grounds that hold sway worldwide. NSFC also discusses with authorities in Beijing, Shanghai

and Anhui Province about the ways to co-fund Basic Science Center Programs. NSFC continues to optimize approach of funding in different fields to accommodate new scientific trends, with more attention to inter-disciplinary research.

Deepen opening-up and cooperation and expand the scope of collaborative innovation. NSFC continues to engage in international exchange and cooperation and gain a footing in the global innovation network. It hosted the International Symposium on Funding Science and People Cooperation for a Prosperous Belt and Road and charted a roadmap for future scientific collaboration among the Belt and Road (B&R) countries and regions in the Symposium's Joint Declaration on Funding Science and People Collaboration for a Prosperous Belt and Road. NSFC works to welcome more international young talents to work in China and improve funding through the Research Fund for International Young Scientists. In its role as a guiding institution, NSFC attracts China's private sector to channel resources into basic research in a collective effort to find answers to key scientific questions to meet the needs of regions, industries and corporations. NSFC also engages in strategic collaboration with the Equipment Development Department and the Science and Technology Department under the MOD, in a bid to explore new mechanisms for military-civil integration in basic research.

Focus on building a clean and honest research environment. NSFC continues to be an advocate for research integrity and adopts a zero tolerance approach to research misconduct. Represented at the Joint Meeting on Building Research Integrity, NSFC took part in the amendment of the meeting's agenda. After publications by Chinese scholars were nullified by the journal *Tumor Biology*, people responsible have been investigated and held to account. NSFC is laser focusing on supervision of program review and continues to delegate member of its Supervision Commission to review panels of all main programs of NSFC. Last year, Hunan, Anhui and Jiangxi Provinces were selected to be audited.

The successful convening of the 19th CPC Congress marks a new era for Socialism with Chinese Characteristics. Indeed, China now finds itself in a new historical period. In a bid to transform China from a major country into a strong country in terms of basic research, "four breakthroughs" are key in this new era, including major breakthrough in pioneering basic research and groundbreaking and original innovations, breakthrough in applied basic research in serving strong nation building, breakthrough in comprehensive intelligence support with better human resources training and team building, and breakthrough in the world status of China's science community in pushing for national rejuvenation.

In 2018, NSFC will continue to thoroughly study, advocate and give substance to the spirit of the 19th CPC Congress. Guided by Xi Jinping Thought on Socialism with Chinese Characteristics in a New Era and in keeping with basic strategic planning in building Socialism with Chinese Characteristics, NSFC will exercise what is required of basic research in the new era and implement the "13th Five Year of NSFC". NSFC will foster the capacity for source innovation in all fields and create a positive environment for innovation, by improving the top level planning, including on funding allocation. NSFC shall remain true to its original aspiration, keep its mission firmly in mind and forge ahead with full vigor to strive for a new landscape in its works, for the sake of prosperity in basic research and for greater scientific strength of China.

contents

Part I

Financial Statistics of NSFC's Funding in 2017

1.1 Financial Budget and Expenditure for NSFC in 2017

In 2017, the financial budget (excluding for the Recuitment Program of Global Expert) for NSFC was 26.771 billion yuan of which the budget for projects approved was 26.489 billion yuan. The financial allocation for NSFC was 26.355 billion yuan with a total direct funding of 24.3 billion yuan and a total indirect funding of 2.055 billion yuan.

In 2017, the total funding for NSFC programs was 29.867 billion yuan with a total direct funding of 25.295 billion yuan and indirect funding of 4.571 billion yuan verified to 1,534 host institutions.

Statistics of Financial Budget for NSFC in 2017

(Unit: 10,000 yuan)

Type of Project	Financial Budget	Financial Expenditure
National Natural Science Fund	2,590,160	2,578,059
National Science Fund for Distinguished Young Scholars	58,770	57,425
Total	2,648,930	2,635,484

1.2 Funding for Projects Approved in 2017

Statistics of NSFC Funding for Projects Approved in 2017

(Unit: 10,000 yuan)

Type of Project		No. of Awards	Approved		
			Direct Funding	Indirect Funding	Total
General Program		18,136	1,068,590.00	204,228.23	1,272,818.23
Key Program		667	198,700.00	37,440.59	236,140.59
Major Program		40	65,413.55	12,264.78	77,678.33
Major Research Plan		535	84,799.40	14,492.39	99,291.79
International (Regional) Joint Research Program		477	94,790.52	17,655.98	112,446.50
Young Scientists Fund		17,523	400,270.00	76,047.49	476,317.49
Fund for Less Developed Regions		3,017	109,520.00	21,174.00	130,694.00
Excellent Young Scientists Fund		399	51,870.00	7,980.00	59,850.00
National Science Fund for Distinguished Young Scholars		198	67,935.00	9,705.00	77,640.00
Fund for Creative Research Groups	New Project	38	38,955.00	5,565.00	44,520.00
	Extended Project	9	4,725.00	675.00	5,400.00
Joint Research Fund for Overseas Scholars in Hong Kong and Macao	Two-Year Project	120	2,160.00	240.00	2,400.00
Four-Year Extended Project		22	3,960.00	440.00	4,400.00
Joint Fund		793	123,246.00	22,788.01	146,034.01
Basic Science Center Program		4	73,000.00	8,919.32	81,919.32
Special Fund for National Major Scientific Research Equipment		88	91,799.89	12,730.96	104,530.85
Projects of Emergency Management		1,089	35,535.55	3,974.57	39,510.12
Tianyuan Fund of Mathematics		82	2,500.00		2,500.00
Research Fund for International Young Scientist		155	4,500.00	812.71	5,312.71
Fund for International (Regional) Cooperation and Exchange		543	7,246.35		7,246.35
Total		43,935	2,529,516.26	457,134.03	2,986,650.29

1.3 Funds for Research Programs

General Program Projects

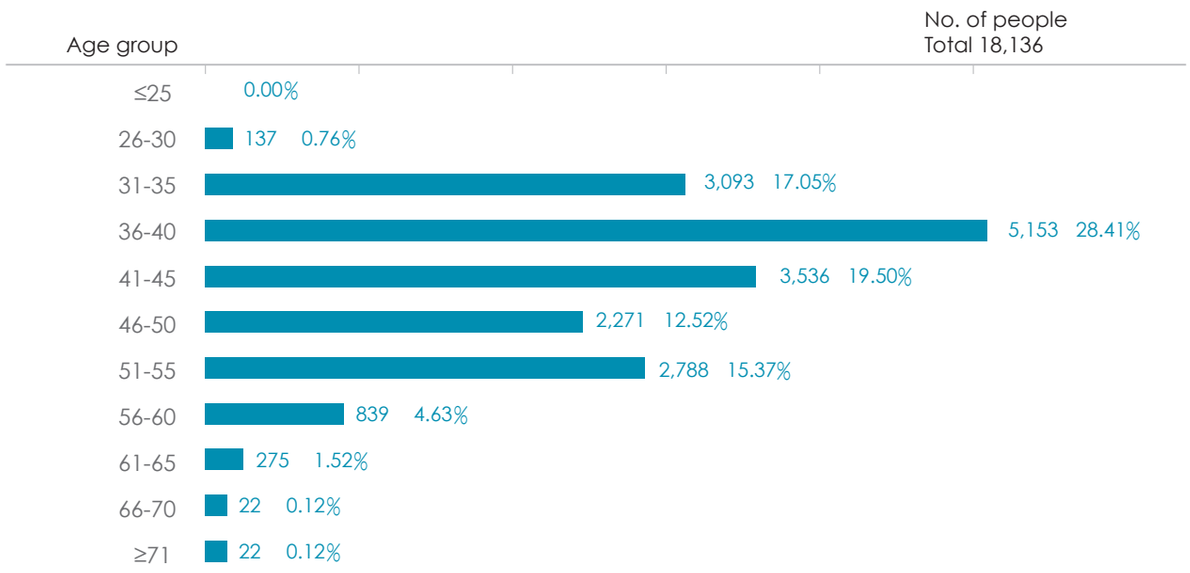
Application and Funding Statistics of General Program Projects in 2017
(by Scientific Department)

(Unit: 10,000 yuan)

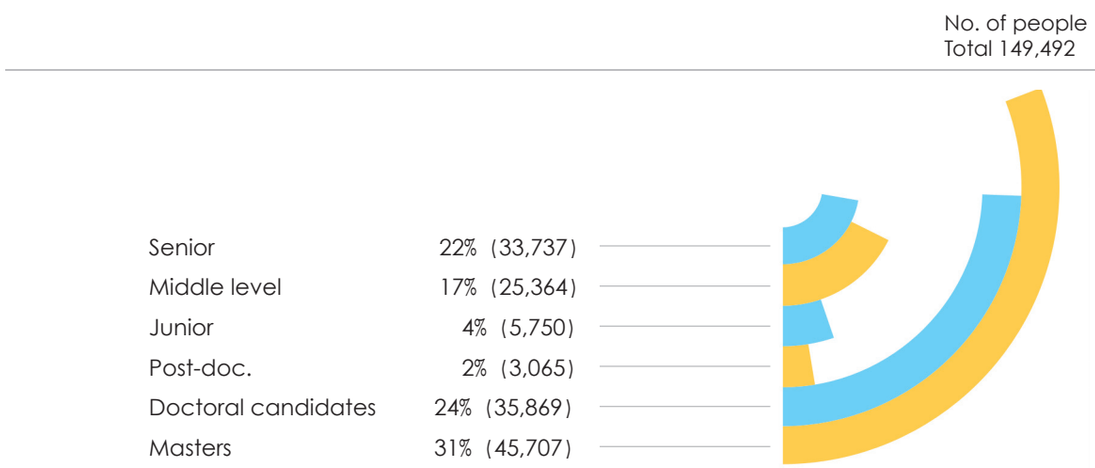
Scientific Department	No. of Applications	Approved				Funding Rate (%)
		No. of Awards	Direct Funding	Percentage of the Total (%)	Average Funding Per Project*	
Mathematical and Physical Sciences	5,804	1,673	100,480.00	9.40	60.06	28.82
Chemical Sciences	6,577	1,671	107,630.00	10.07	64.41	25.41
Life Sciences	11,028	2,902	170,030.00	15.91	58.59	26.31
Earth Sciences	6,272	1,683	113,070.00	10.58	67.18	26.83
Engineering and Materials Sciences	14,706	3,085	185,120.00	17.32	60.01	20.98
Information Sciences	8,867	1,912	113,880.00	10.66	59.56	21.56
Management Sciences	4,072	755	36,240.00	3.39	48.00	18.54
Health Sciences	22,965	4,455	242,140.00	22.66	54.35	19.40
Total	80,291	18,136	1,068,590.00	100	58.92	22.59

Note: average direct funding per project = total direct cost/No. of projects; funding rate = No. of approved/No. of applications*100.There were 58,998 proposals from male PIs and 21,293 funded; 13,687 from female and 4,449 funded.

Age Distribution of Principal Investigators of General Program Projects in 2017



Professional Structure of Members of Research Groups for General Program Projects in 2017



Statistics of General Program Projects by Region in 2017

(Unit: 10,000 yuan)

No.	Region	No. of Awards	Direct Funding	No.	Region	No. of Awards	Direct Funding
1	Beijing	3,341	200,571.30	17	Jilin	372	22,654.00
2	Shanghai	2,113	122,057.90	18	Henan	276	15,874.00
3	Jiangsu	1,868	109,506.00	19	Gansu	196	12,211.00
4	Guangdong	1,521	88,438.90	20	Hebei	149	8,697.00
5	Hubei	1,201	70,840.20	21	Yunnan	122	7,341.00
6	Zhejiang	901	52,146.20	22	Shanxi	109	6,428.00
7	Shaanxi	868	51,925.50	23	Jiangxi	71	4,121.00
8	Shandong	772	46,035.00	24	Guangxi	47	2,703.00
9	Sichuan	643	37,951.00	25	Guizhou	43	2,764.00
10	Liaoning	628	36,759.50	26	Xinjiang	40	2,299.00
11	Hunan	580	33,469.50	27	Hainan	28	1,671.00
12	Tianjin	478	28,043.00	28	Inner Mongolia	21	1,230.00
13	Heilongjiang	472	27,398.00	29	Ningxia	6	342.00
14	Anhui	462	28,072.00	30	Qinghai	5	295.00
15	Fujian	406	23,768.00	31	Tibet	1	66.00
16	Chongqing	396	22,912.00				

Key Program Projects

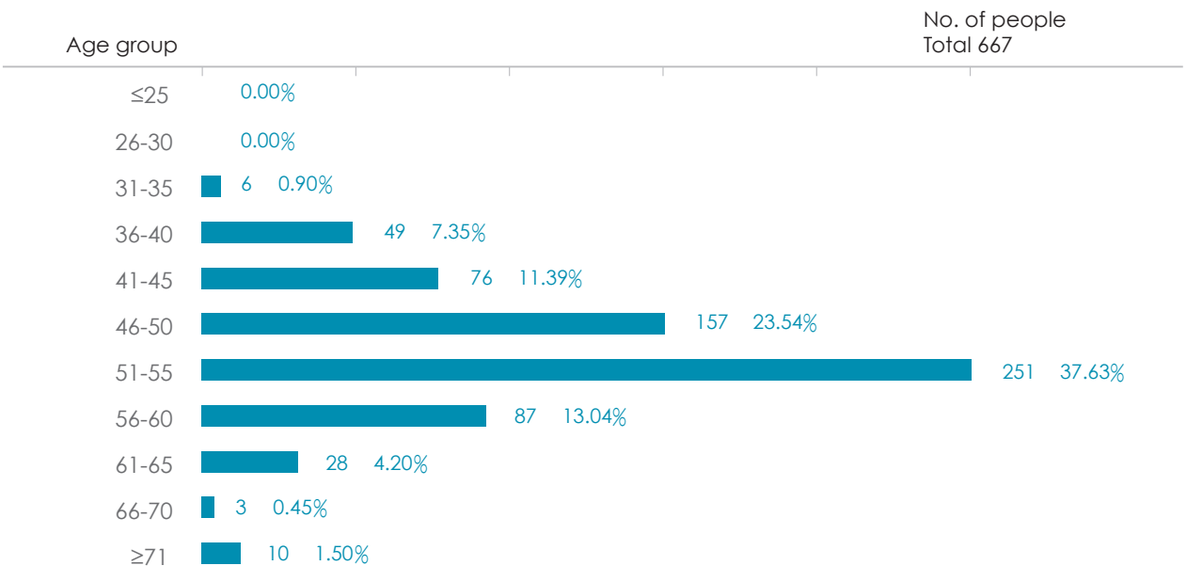
Application and Funding of Key Program Projects in 2017
(by Scientific Department)

(Unit: 10,000 yuan)

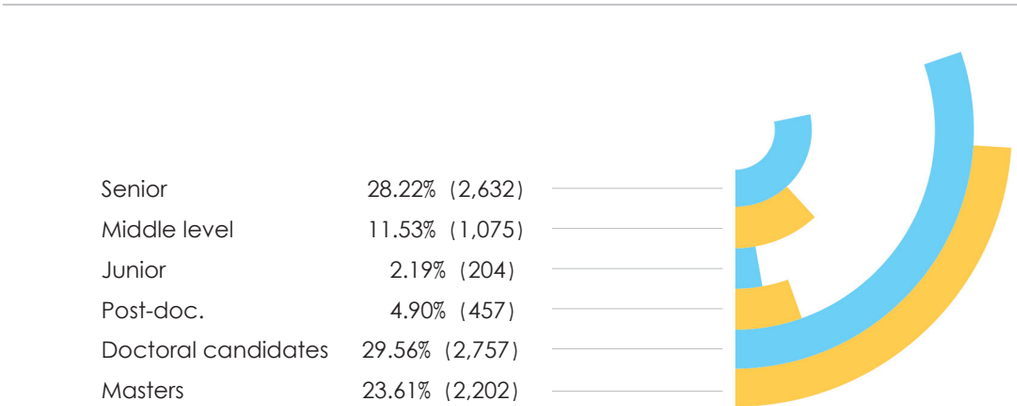
Scientific Departments	No. of Applications	Approved				Success Rate (%)
		No. of Awards	Direct Funding	Percentage of the Total (%)	Average Funding Per Project	
Mathematical and Physical Sciences	281	76	23,850.00	12.00	313.82	27.05
Chemical Sciences	239	62	18,600.00	9.36	300.00	25.94
Life Sciences	537	112	33,500.00	16.86	299.11	20.86
Earth Sciences	481	89	28,080.00	14.13	315.51	18.50
Engineering and Materials Sciences	457	99	29,700.00	14.95	300.00	21.66
Information Sciences	267	89	25,500.00	12.83	286.52	33.33
Management Sciences	108	28	6,720.00	3.38	240.00	25.93
Health Sciences	642	112	32,750.00	16.48	292.41	17.45
Total	3,012	667	198,700.00	100	297.90	22.14

Note: 2,623 proposals from male PIs, 583 granted; 389 from female and 84 granted.

Age Distribution of Principal Investigators of Key Program Projects in 2017



Professional Structure of Members of Research Groups for Key Program Projects in 2017



International (Regional) Cooperation Program

Application and Funding of Projects of Key International (Regional) Joint Research Program in 2017 (by Scientific Department)

(Unit: 10,000 yuan)

Scientific Departments	No. of Applications	Approved				Success Rate (%)
		No. of Awards	Direct Funding	Percentage of the Total (%)	Average Funding Per Project*	
Mathematical and Physical Sciences	31	4	1,110.00	4.35	277.50	12.90
Chemical Sciences	38	7	1,690.00	6.63	241.43	18.42
Life Sciences	83	19	4,630.00	18.16	243.68	22.89
Earth Sciences	56	9	2,220.00	8.71	246.67	16.07
Engineering and Materials Sciences	95	16	3,630.00	14.24	226.88	16.84
Information Sciences	85	15	3,680.00	14.43	245.33	17.65
Management Sciences	18	4	860.00	3.37	215.00	22.22
Health Sciences	203	33	7,680.00	30.12	232.73	16.26
Total	609	107	25,500.00	100	238.32	17.57

Application and Funding of Projects of International (Regional) Cooperation Program in 2017 (by Scientific Department)

(Unit: 10,000 yuan)

Scientific Departments	No. of Applications	Approved				Success Rate (%)
		No. of Awards	Direct Funding	Percentage of the Total (%)	Average Funding Per Project	
Mathematical and Physical Sciences	144	36	6,099.00	8.80	169.42	25.00
Chemical Sciences	211	46	8,970.72	12.95	195.02	21.80
Life Sciences	221	52	9,216.50	13.30	177.24	23.53
Earth Sciences	243	50	9,330.31	13.47	186.61	20.58
Engineering and Materials Sciences	607	86	16,566.74	23.91	192.64	14.17
Information Sciences	267	40	6,198.40	8.95	154.96	14.98
Management Sciences	79	11	1,985.00	2.86	180.45	13.92
Health Sciences	486	49	10,923.85	15.77	222.94	10.08
Total	2,258	370	69,290.52	100	187.27	16.39

Projects for Young Scientists Fund

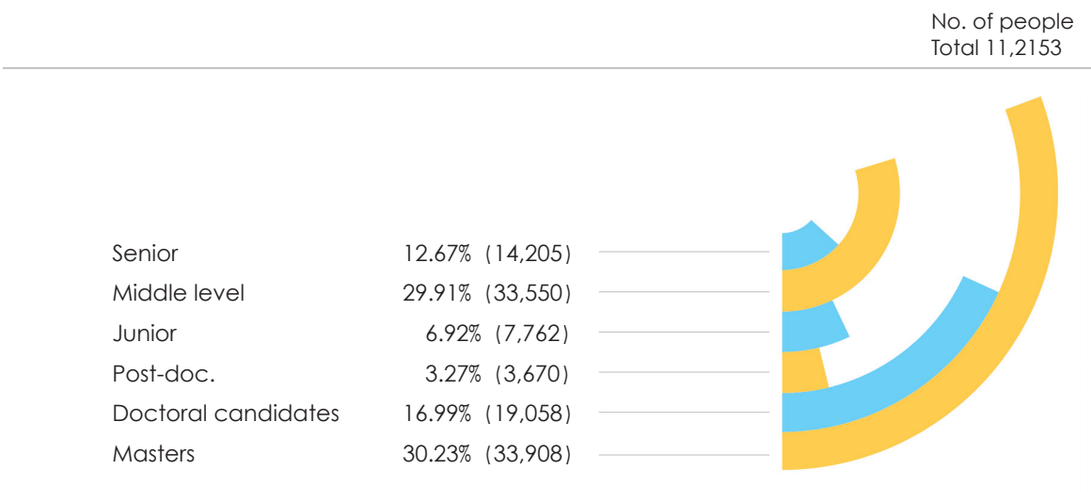
Application and Funding of Projects of Young Scientists Fund in 2017
(by Scientific Department)

(Unit: 10,000 yuan)

Scientific Departments	No. of Applications	Approved				Success Rate (%)
		No. of Awards	Direct Funding	Percentage of the Total (%)	Average Funding Per Project	
Mathematical and Physical Sciences	5,899	1,749	42,160.00	10.53	24.11	29.65
Chemical Sciences	6,161	1,541	37,400.00	9.34	24.27	25.01
Life Sciences	10,566	2,395	57,460.00	14.36	23.99	22.67
Earth Sciences	6,026	1,712	41,270.00	10.31	24.11	28.41
Engineering and Materials Sciences	13,131	3,080	73,910.00	18.47	24.00	23.46
Information Sciences	7,620	2,031	49,370.00	12.33	24.31	26.65
Management Sciences	4,127	815	14,690.00	3.67	18.02	19.75
Health Sciences	24,665	4,200	84,010.00	20.99	20.00	17.03
Total	78,195	17,523	400,270.00	100	22.84	22.41

Note: 39,663 proposals from male PIs and 10,380 granted; 38,532 from female, 7,143 granted.

Professional Structure of Members of Research Groups for Young Scientists Fund in 2017



Statistics of Projects for Young Scientists Fund by Region in 2017

(Unit: 10,000 yuan)

No.	Region	No. of Awards	Direct funding	No.	Region	No. of Awards	Direct funding
1	Beijing	2,301	52,753.80	16	Fujian	407	9,290.90
2	Jiangsu	1,974	44,880.90	17	Heilongjiang	350	8,115.50
3	Guangdong	1,594	36,024.30	18	Jilin	301	7,093.40
4	Shanghai	1,420	31,302.90	19	Shanxi	227	5,260.40
5	Hubei	1,133	25,903.90	20	Gansu	180	4,365.50
6	Shandong	998	23,237.30	21	Hebei	187	4,304. 10
7	Shaanxi	1,001	23,131.30	22	Jiangxi	156	3,624.70
8	Zhejiang	885	19,911.60	23	Yunnan	135	3,179.60
9	Sichuan	771	17,626.50	24	Guangxi	87	2,002.00
10	Liaoning	627	14,369.50	25	Guizhou	76	1,770.10
11	Hunan	600	13,619.10	26	Xinjiang	51	1,245.00
12	Henan	575	13,175.10	27	Hainan	46	1,080.50
13	Anhui	472	11,129.40	28	Inner Mongolia	30	708.10
14	Tianjin	472	10,765.90	29	Qinghai	16	367.00
15	Chongqing	440	9,784.70	30	Ningxia	11	247.00

Projects of the Fund for Less Developed Regions

Application and Funding of Projects of the Fund for Less Developed Regions by Funding in 2017

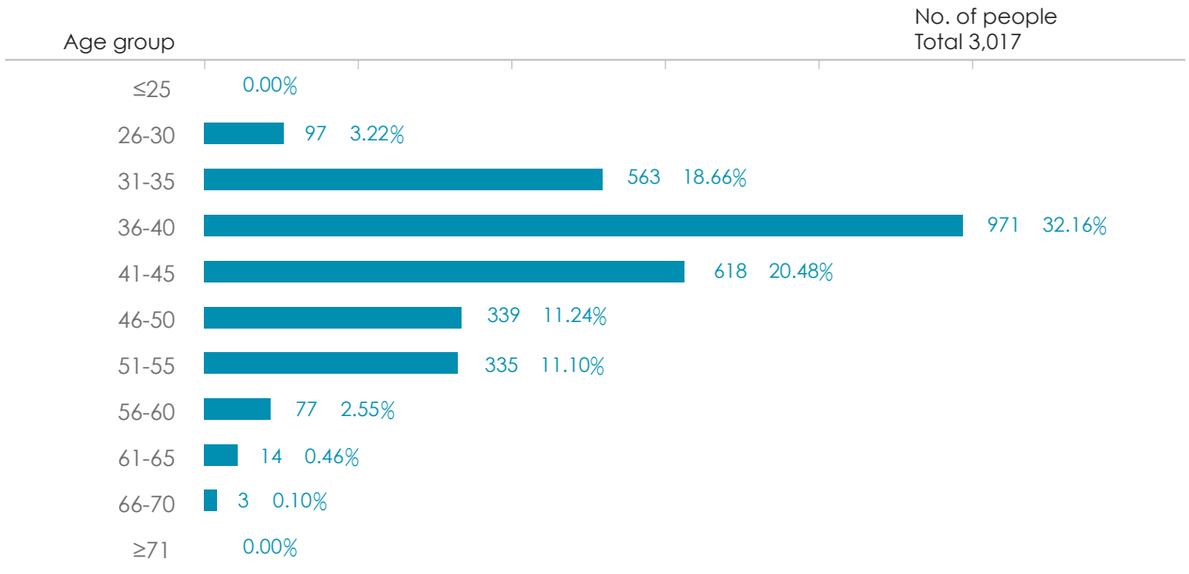
(Unit: 10,000 yuan)

Scientific Departments	No. of Applications	Approved				Success Rate (%)
		No. of Awards	Direct Funding	Percentage of the Total (%)	Average Funding Per Project	
Jiangxi	2,943	604	21,728.50	19.84	35.97	20.52
Yunnan	2,522	482	17,505.00	15.98	36.32	19.11
Guangxi	2,184	413	14,881.50	13.59	36.03	18.91
Xinjiang	1,883	328	11,914.00	10.88	36.32	17.42
Guizhou	1,594	285	10,219.00	9.33	35.86	17.88
Gansu	1,340	249	9,251.00	8.45	37.15	18.58
Inner Mongolia	1,316	229	8,492.50	7.75	37.09	17.40
Ningxia	720	142	5,087.50	4.65	35.83	19.72
Hainan	515	112	4,081.00	3.73	36.44	21.75

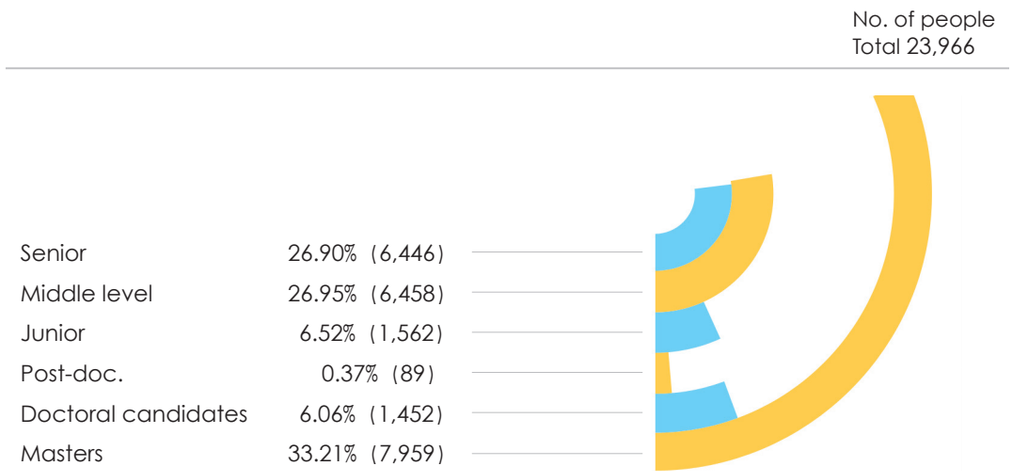
Application and Funding of Projects of the Fund for Less Developed Regions by Funding in 2017 (Continued)

Scientific Departments	No. of Applications	Approved				Success Rate (%)
		No. of Awards	Direct Funding	Percentage of the Total (%)	Average Funding Per Project	
Qinghai	292	50	1,840.50	1.68	36.81	17.12
Tibet	98	28	1,065.00	0.97	38.04	28.57
Shanxi						
Yan'an	64	16	577.00	0.53	36.06	25.00
Yulin	99	8	306.00	0.28	38.25	8.08
Jilin						
Yanbian	232	41	1,451.50	1.33	35.40	17.67
Hunan						
Xiangxi	63	20	762.00	0.70	38.10	31.75
Hubei						
Enshi	53	9	319.00	0.29	35.44	16.98
Sichuan						
Liangshan	12	1	39.00	0.04	39.00	8.33
Ganzi	2	0.00	0.00	0.00		
Aba	3	0.00	0.00	0.00		
Total	15,935	3,017	109,520.00	100	36.30	18.93

Note: there were 10,223 applications from male applicants, of which 1,978 were funded; and 5,712 from female applicants, 1,039 funded.



Age Distribution of Principal Investigators of Projects of the Fund for Less Developed Regions in 2017



Professional Structure of Members of Research Groups for the Fund for Less Developed Regions in 2017

Excellent Young Scientists Fund

Application and Funding of Projects of Excellent Young Scientists Fund in 2017 (by Scientific Department)

(Unit: 10,000 yuan)

Scientific Departments	No. of Applications	Approved		
		Projects	Direct Funding	Percentage of the Total (%)
Mathematical and Physical Sciences	563	48	6,240.00	12.03
Chemical Sciences	695	57	7,410.00	14.29
Life Sciences	716	58	7,540.00	14.54
Earth Sciences	473	39	5,070.00	9.77
Engineering and Materials Sciences	888	73	9,490.00	18.30
Information Sciences	761	59	7,670.00	14.79
Management Sciences	183	15	1,950.00	3.76
Health Sciences	588	50	6,500.00	12.53
Total	4,867	399	51,870.00	100

Note: there were 3,978 applications from male applicants, of which 320 were funded; and 889 from female applicants, 79 funded.

National Science Fund for Distinguished Young Scholars

In 2017, 2,684 applications were received for National Science Fund for Distinguished Young Scholars. After review, 198 people were funded. The total direct funding was 679.35 million yuan.

Awardees of the National Science Fund for Distinguished Young Scholars in 2017

No.	Name	Home Institution
1	Lei Zhen	Fudan University
2	Liu Siqi	Tsinghua University
3	Liu Yingzheng	Shanghai Jiao Tong University
4	Yue Mu	Tsinghua University
5	Huang Jiping	Fudan University
6	Wang Haohua	Zhejiang University
7	Peng Liangyou	Peking University
8	Yuan Yefei	University of Science and Technology of China
9	Wang Hongtao	Zhejiang University
10	Feng Ji	Zhejiang University
11	Cao Qinghong	Peking University
12	Zhou Shuyun	Tsinghua University
13	Ding Longyun	Nankai University
14	Zheng Weiying	Academy of Mathematics and Systems Science, CAS
15	Liu Ruochuan	Peking University
16	Lyu Haibao	Harbin Institute of Technology
17	Fu Zhubin	Institute of Applied Physics and Computational Mathematics
18	Lian Zeng	Sichuan University

No.	Name	Home Institution
19	Ke Liaoliang	Beijing Jiaotong University
20	Li Miao	National Astronomical Observatory of China
21	Chen Xiaoqian	National University of Defense Technology
22	Cai Qingyu	Wuhan Institute of Physics and Mathematics, CAS
23	Wu Xuefeng	Purple Mountain Observatory, CAS
24	Huang Mei	Institute of High Energy Physics, CAS
25	Liang Gaolin	University of Science and Technology of China
26	Zhang Wenxiong	Peking University
27	Xiong Yujie	University of Science and Technology of China
28	Yang Caiguang	Shanghai Institute of Medicine, CAS
29	Wu Decheng	Institute of Chemistry, CAS
30	Zhang Fan	Fudan University
31	Chu Guangwen	Beijing University of Chemical Technology
32	Jiang Hailong	University of Science and Technology of China
33	Huang Weilong	Wuhan University
34	Ma Ding	Peking University
35	Zou Bo	Jilin University
36	Jiang Ying	Peking University

Awardees of the National Science Fund for Distinguished Young Scholars in 2017 (Continued)

No.	Name	Home Institution
37	Chen Xuebo	Beijing Normal University
38	Yao Maosheng	Peking University
39	Hou Junli	Fudan University
40	Wang Leyu	Beijing University of Chemical Technology
41	Xing Huabin	Zhejiang University
42	Chen Gong	Nankai University
43	Jin Shengye	Dalian Institute of Chemical Physics, CAS
44	Cheng Yiyun	East China Normal University
45	Liu Mingjie	Beihang University
46	Zhang Xinbo	Changchun Institute of Applied Chemistry, CAS
47	Wang Dong	Institute of Chemistry, CAS
48	Nie Zhou	Hunan University
49	Deng Liang	Shanghai Institute of Organic Chemistry, CAS
50	Tang Wenjun	Shanghai Institute of Organic Chemistry, CAS
51	Yin Shuangfeng	Hunan University
52	Zhou Jian	East China Normal University
53	Zhao Xin	Shanghai Institute of Organic Chemistry, CAS
54	Zhang Lihua	Dalian Institute of Chemical Physics, CAS
55	Xie Wei	Tsinghua University
56	Gao Yongchun	Fudan University
57	Kong Fanjiang	Northeast Institute of Geography and Agricultural Ecology, CAS
58	Zhang Quanguo	Beijing Normal University
59	Qin Genji	Peking University
60	Gao Ning	Peking University
61	Xu Pinglong	Zhejiang University
62	Hu Xiaoyu	Tsinghua University
63	Chen Lili	Huazhong University of Science and Technology
64	Zhu Jian	Peking University
65	Shan Ge	University of Science and Technology of China
66	Yu Jia	Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences
67	Xiao Shi	Sun Yat-sen University
68	Hu Wei	Fudan University
69	Wang Yonghua	South China University of Technology
70	Chen Linglin	Shanghai Institutes for Biological Sciences
71	Li Haitao	Tsinghua University
72	Shen Xihui	Northwest A&F University
73	Cai Lei	Institute of Microbiology, CAS
74	Zhu Yan	Nanjing Agricultural University
75	Li Qing	Peking University
76	Wu Jun	Nanjing Agricultural University
77	Dai Junbiao	Shenzhen Institutes of Advanced Technology, CAS
78	Wang Yanli	Institute of Biophysics, CAS

Awardees of the National Science Fund for Distinguished Young Scholars in 2017 (Continued)

No.	Name	Home Institution
79	Zhang Yongan	Institute of Hydrobiology, CAS
80	Wang Guirong	Institute of Plant Protection, CAS
81	Yang Xiaozhi	Nanjing University
82	Yang Haijun	Peking University
83	Chen Huayong	Guangzhou Institute of Geochemistry, CAS
84	Peng Xinhua	Institute of Soil Science, CAS
85	Feng Shijin	Tongji University
86	Hou Zhujun	East China Normal University
87	Huang Wei	University of Science and Technology of China
88	Ding Aijun	Nanjing University
89	Yang Bisheng	Wuhan University
90	Duan Anmin	Institute of Atmospheric Physics, CAS
91	Hu Zhaochu	China University of Geosciences (Wuhan)
92	Cheng Hefa	Peking University
93	Ge Yong	Institute of Geographic Sciences and Natural Resources Research, CAS
94	Yang Shiling	Institute of Geology and Geophysics, CAS
95	Zhang Yangjian	Institute of Geographic Sciences and Natural Resources Research, CAS
96	Pan Bo	Kunming University of Science and Technology
97	Fan Junxuan	Nanjing Institute of Geology and Palaeonotology, CAS
98	Zhang Huai	University of Chinese Academy of Sciences
99	Wu Guangjian	Institute of Tibetan Plateau Research, CAS

No.	Name	Home Institution
100	Tang Yanjie	Institute of Geology and Geophysics, CAS
101	Zhang Shuanhong	Institute of Geology and Mechanics, CAS
102	Che Renchao	Fudan University
103	Kang Zhenhui	Suzhou University
104	Zhu Tiejun	Zhejiang University
105	Fan Jiansheng	Tsinghua University
106	Liu Yong	Ocean University of China
107	Wu Wenchuan	Tsinghua University
108	Wang Shurong	Zhejiang University
109	Shen Zhizui	Peking University
110	Wang Jinting	Tsinghua University
111	Wang Xinyun	Huazhong University of Science and Technology
112	Xu Changjie	East China Jiaotong University
113	Du Taisheng	China Agricultural University
114	Dong Huanli	Institute of Chemistry, CAS
115	Chen Jianbing	Tongji University
116	Bu Wenbo	East China Normal University
117	Wu Di	Nanjing University
118	Jiao Shuqiang	University of Science and Technology Beijing
119	Huang Zhongwei	China University of Petroleum(Beijing)
120	Li Shuiqing	Tsinghua University

Awardees of the National Science Fund for Distinguished Young Scholars in 2017 (Continued)

No.	Name	Home Institution
121	Bi Tianmei	North China Electric Power University
122	Zhang Jixiong	China University of Mining and Technology
123	Xia Junqiang	Wuhan University
124	Wang Hao	National Centre for Nanoscience and Nanotechnology
125	Zhou Shaobing	Southwest Jiaotong University
126	Xie Kaigui	Chongqing University
127	Jiang Chao	Hunan University
128	Yin Xiaowei	Northwestern Polytechnical University
129	Guo Anxin	Harbin Institute of Technology
130	Yang Huagui	East China University of Science and Technology
131	Sun Yang	Institute of Physics, CAS
132	Chen Huawei	Beihang University
133	Zhan Xiancheng	East China University of Science and Technology
134	Chen Yongping	Suzhou University of Science and Technology
135	Zhang Lifeng	University of Science and Technology Beijing
136	Zhang Jianhua	Shanghai University
137	Chen Xingqiu	Institute of Metal Research, CAS
138	Hu Yongsheng	Institute of Physics, CAS
139	Yan Denghua	Institute of Water Resource and Hydraulic Research
140	Yu Junzhi	Institute of Automation, CAS
141	Xu Jinshi	University of Science and Technology of China

No.	Name	Home Institution
142	Zhang Chaoyang	Zhejiang University
143	Tang Jiang	Huazhong University of Science and Technology
144	Dai Daoxin	Zhejiang University
145	Kang Yu	University of Science and Technology of China
146	Lu Huchuan	Dalian University of Technology
147	Liu Yongjin	Tsinghua University
148	Jiang Jie	Beihang University
149	Huang Gang	Peking University
150	Shen Hongbin	Shanghai Jiao Tong University
151	Wang Meng	Hefei University of Technology
152	Xie Gaogang	Institute of Computing Technology, CAS
153	Zeng Haibo	Nanjing University of Science and Technology
154	Xie Yongfang	Central South University
155	Du Wenli	East China University of Science and Technology
156	Li Dabing	Changchun Institute of Optics, Fine Mechanics and Physics, CAS
157	Yu Zhiwen	Northwestern Polytechnical University
158	Huang Panfeng	Northwestern Polytechnical University
159	Zhang Xiuyin	East China University of Science and Technology
160	Fu Kun	Institute of Electrics, CAS
161	Wang Jianpu	Nanjing University of Technology
162	Wang Yeliang	Institute of Physics, CAS

Awardees of the National Science Fund for Distinguished Young Scholars in 2017 (Continued)

No.	Name	Home Institution	No.	Name	Home Institution
163	Sheng Min	Xidian University	181	Luo Junhang	Sun Yat-sen University
164	Hu Weida	Shanghai Institute of Technical Physics, CAS	182	Tian Mei	Zhejiang University
165	Du Shefeng	Institute of Acoustics, CAS	183	Wang Lei	Fudan University
166	Ai Bo	Beijing Jiaotong University	184	Ye Min	Peking University
167	Li Ling	Institute of Microelectronics, CAS	185	Zhang Yonghui	Huazhong University of Science and Technology
168	Chen Bin	Beijing Normal University	186	Li Huabin	Fudan University
169	Li Yongjian	Nankai University	187	Xu Yong	Nanjing Medical University
170	Kou Gang	Southwestern University of Finance and Economics	188	Zou Weiguo	Shanghai Institute of Organic Chemistry, CAS
171	Fang Debin	Wuhan University	189	Qin Guoliang	Wuhan University
172	Weng Wenguo	Tsinghua University	190	Wang Renxiao	Shanghai Institute of Organic Chemistry, CAS
173	Wang Yonggui	University of International Business and Economics	191	Hu Guohong	Shanghai Institute of Organic Chemistry, CAS
174	Wu Junjie	Beihang University	192	Wu Chen	Cancer Hospital, Chinese Academy of Medical Sciences
175	Zhao Zhuo	Fudan University	193	Xu Huixiiong	Tongji University
176	Sun Aijun	Fudan University	194	Shang Hongcai	Beijing University of Chinese Medicine
177	Wang Honglin	Shanghai Jiao Tong University	195	Zhou Zhaocai	Shanghai Institutes for Biological Sciences
178	You Sa	Xiamen University	196	Wang Junping	Army Medical University
179	Dong Zhongjun	Tsinghua University	197	Wang Fei	China Medical University
180	Sheng Chunquan	The Second Military Medical University	198	Duan Shengzhong	Shanghai Jiao Tong University

Basic Science Center Project

Applications and Funding of Basic Science Center Project

(Unit: 10,000 yuan)

No.	Title of Project	PI	Home Institution	Direct Funding
1	Innate immunity and inflammatory diseases	Cao Xuetao	Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences	19,000.00
2	Luminescence from molecular aggregates	Tang Benzhong	South China University of Technology	18,000.00
3	Designing future crops	Han Bin	Shanghai Institute of Organic Chemistry, CAS	18,000.00
4	Towards high efficient materials via reconstructing correlation effects	Nan Cewen	Tsinghua University	18,000.00
Total				73,000.00

Joint Research Fund for Overseas Chinese Scholars and Scholars in Hong Kong and Macao

The Joint Research Fund for Overseas Chinese Scholars and Scholars in Hong Kong and Macao adopts "2+4" funding model, which means that those 2-year projects with substantial cooperation and strong potential for future development will be renewed to another 4 years.

Joint Research Fund for Overseas Chinese Scholars and Scholars in Hong Kong and Macao in 2017

(Unit: 10,000 yuan)

Scientific Department	Two-Year Projects			Projects Extended to Four-Year		
	No. of Applications	Approved		No. of Applications	Approved	
		No. of Awards	Direct Funding		No. of Awards	Direct Funding
Mathematical and Physical Sciences	20	9	162.00	8	2	360.00
Chemical Sciences	31	10	180.00	8	2	360.00
Life Sciences	40	16	288.00	12	4	720.00
Earth Sciences	20	8	144.00	8	2	360.00
Engineering and Material Sciences	43	17	306.00	10	3	540.00
Information Sciences	88	28	504.00	15	4	720.00
Management Sciences	28	10	180.00	3		180.00
Health Sciences	59	22	396.00	18	4	720.00
Total	329	120	2,160.00	82	22	3,960.00

Science Fund for Creative Research Groups

1. Newly started creative research groups

In 2017, 256 applications were received. After review, 38 groups were supported, with a total direct funding of 389.55 million yuan. Please refer to the following table for details.

Awards in the Science Fund for Creative Research Groups in 2017

No.	Group Leader	Home Institution	No.	Group Leader	Home Institution
1	Li Jiayu	University of Science and Technology of China	16	Gao Shuji	Xiamen University
2	Han Liang	University of Science and Technology of China	17	Shen Yanan	University of Science and Technology of China
3	Jin Kuijuan	Institute of Physics, CAS	18	Xu Jianming	Zhejiang University
4	He Zishan	Peking University	19	Li Jiancheng	Wuhan University
5	Wang Jinjun	Beihang University	20	Chen Wen	Institute of Atmospheric Physics, CAS
6	Xie Suyuan	Xiamen University	21	Chen Yanfeng	Nanjing University
7	Zhou Xiang	Wuhan University	22	Ni Jinmin	Peking University
8	Lu Lehui	Changchun Institute of Applied Chemistry, CAS	23	Wu Limin	Fudan University
9	Tang Zhiyong	National Center for Nanoscience and Technology	24	He Yaling	Xi'an Jiaotong University
10	Zhang Tao	Dalian Institute of Chemical Physics, CAS	25	Xiao Liye	Institute of Electrical Engineering, CAS
11	Gao Shaorong	Tongji University	26	Wang Shuxin	Tianjin University
12	Xue Hongwei	Shanghai Institutes for Biological Sciences, CAS	27	Yang Deren	Zhejiang University
13	Lu Youming	Huazhong University of Science and Technology	28	Zhang Xuegong	Tsinghua University
14	Hu Wei	Institute of Hydrobiology, CAS	29	Zheng Qinghua	Xi'an Jiaotong University
15	Wang Yuanchao	Nanjing Agricultural University	30	Hu Jun	University of Electronic Science and Technology of China

Awards in the Science Fund for Creative Research Groups in 2017 (Continued)

No.	Group Leader	Home Institution	No.	Group Leader	Home Institution
31	Liu Chenglin	Institute of Automation, CAS	35	Chen Jianguo	Huazhong University of Science and Technology
32	Li Zhongfei	Sun Yat-sen University	36	Liu Yizhi	Sun Yat-sen University
33	Su Jun	Tsinghua University	37	Zhu Zhiming	Army Medical University
34	Chen Guoqiang	Shanghai Jiao Tong University	38	Wang Fusheng	302 Military Hospital of China

2. Continued funding for creative research groups

Among the 30 creative research group of 6-year funding, 22 of them applied for extended funding. After evaluation, 9 creative research groups obtained the second term of funding. The total funding was 47.25 million yuan. Please refer to the following table for details.

Continued funding for Creative Research Groups of 6-year funding

No.	Group Leader	Home Institution	No.	Group Leader	Home Institution
1	Zhang Jie	Shanghai Jiao Tong University	6	Fang Jiancheng	Beihang University
2	Qin Dahe	Cold and Arid Regions Environmental and Engineering Research Institute, CAS	7	Luo Qingming	Huazhong University of Science and Technology
3	Fu Qiang	Sichuan University	8	Fu Xiaobing	Chinese PLA General Hospital
4	Shao Xinyu	Huazhong University of Science and Technology	9	Zheng Shusen	Zhejiang University
5	Yang Zhifeng	Beijing Normal University			

Research Fund for International Young Scientists

Application and Funding of Projects of Research Fund for International Young Scientists (by Scientific Department) in 2017

(Unit: 10,000 yuan)

Scientific Departments	No. of Applications	Approved			Success Rate (%)
		Direct Funding	Percentage of the Total (%)	Average Funding Per Project	
Mathematical and Physical Sciences	57	25	612.10	13.60	24.48
Chemical Sciences	71	20	623.28	13.85	31.16
Life Sciences	81	30	919.62	20.44	30.65
Earth Sciences	29	11	361.83	8.04	32.89
Engineering and Materials Sciences	71	27	808.70	17.97	29.95
Information Sciences	52	22	566.60	12.59	25.75
Management Sciences	20	8	194.64	4.33	24.33
Health Sciences	32	12	413.23	9.18	34.44
Total	413	155	4,500.00	100	29.03

International (Regional) Exchange Program

Application and Funding of Projects of International (Regional) Exchange Program in 2017

(Unit: 10,000 yuan)

	Application Received	Application Accepted	Projects Funded	Funding Amount
Exchange Program under Agreements/MoUs	1,912	1,671	180	2,907.22
Academic Conference under Agreements/MoUs held abroad	335	329	320	860.94
Academic Conference under Agreements/MoUs held in China	73	69	41	632.66
IIASA Membership Fee	1	1	1	527.43
Sino-German Center for Research Promotion	1	1	1	2,318.10
Total	2,322	2,071	543	7,246.35

Special Fund for Development of National Major Research Instruments and Facilities

In 2017, 591 free applications were received for the Special Fund for Development of National Major Research Instruments and Facilities. After review, 83 applications were funded, with direct funding of 589.7791 million yuan. Some relevant government departments recommended 54 applications. After review, 5 projects were supported, with total funding of 328.2198 million yuan.

Projects funded in Special Fund for Development of National Major Research Instruments and Facilities (by recommendation) in 2017

(Unit: 10,000 yuan)

No.	Project Title	PI	Home Institution	Direct Funding
1	The apparatus for characterizing the optical and electronic properties of single point-defects in wide-bandgap semiconductors	Shen Dezhen	Changchun Institute of Optical Precision Machinery and Physics, CAS	6,507.58
2	Detonation driven hypervelocity and high enthalpy shock tunnel	Jiang Zonglin	Institute of Mechanics, CAS	7,710.20
3	High resolution multi-dimensional radar measurement system oriented to mechanism analysis of aerial animal migration	Long Teng	Beijing Institute of Technology	8,220.00
4	Atom trap instrumentation for radio-krypton and radio-argon dating	Lu Zhengtian	University of Science and Technology of China	3,884.20
5	An experimental facility of in-situ/real time monitoring and control in time and space of varying scales for thin film growth defects	Liu Sheng	Wuhan University	6,500.00
Total			32,821.98	

Emergency Management Projects

NSFC's General Management Projects

88 projects in this category were funded with total direct funding of 123.15 million yuan.

NSFC's Departmental General Management Projects

934 projects in this category were funded with total direct funding of 207.4055 million yuan.

Soft Projects entrusted by NSFC's Functional Departments

67 soft projects or tasks in this category were funded with total direct funding of 24.80 million yuan.

Major Program

Funding of Major Program Projects in 2017

(Unit: 10,000 yuan)

No.	Project Title	PI	Home Institution	Direct Funding
1	Ergodic average and asymptotic behavior of dynamical systems	Cheng Chongqing	Nanjing University	1,684.00
2	Dynamics performance evolution and control of high-speed rail transportation system	Zhai Wanming	Xi'an Jiaotong University	1,678.00
3	Mechanism for plastic flow and strengthening-toughening of disordered alloys	Dai Lanhong	Institute of Mechanics, CAS	1,694.00
4	The study of solar atmospheric magnetic field diagnostics and the related physical processes from the spectral imaging observations	Yan Yihua	National Astronomical Observatory of China	1,663.00
5	Exploration of the high-TC and topological superconductivity in quasi-two dimensional systems	Feng Donglai	Fudan University	1,676.50
6	Research on key scientific problems in nuclear fission data of actinide	Ge Zhigang	China Institute of Atomic Energy	1,673.00
7	Controllable preparation and properties of two-dimensional carbon-graphdiyne	Li Yuliang	Institute of Chemistry, CAS	1,694.80
8	Homogeneous catalytic oxidation and reduction processes towards highly efficient synthesis of fine chemicals	Zhou Qilin	Nankai University	1,676.40
9	Molecular mechanism and performance control of the nonlinear rheological behaviors of polymers	An Lijia	Changchun Institute of Applied Chemistry, CAS	1,698.50
10	High resolution molecular imaging and chemical precision measurements under the localized field	Luo Yi	University of Science and Technology of China	1,685.50
11	Accurate construction of novel hetero polycyclic aromatic systems and their controllable excited states of aggregates	Pei Jian	Peking University	1,695.80
12	Study of actinide chemistry in the complex systems of spent fuel reprocessing	Chai Zhifang	Suzhou University	1,669.55
13	Neurochemical analysis of Parkinson diseases	Mao Lanqun	Institute of Chemistry, CAS	1,677.40
14	Molecular regulation of autophagy	Chen Quan	Institute of Zoology, CAS	1,776.00
15	Genetic mechanisms of myogenesis and intramuscular lipid accumulation in Chinese native pig breeds	Huang Lusheng	Jiangxi Agricultural University	1,784.00
16	Climate change and sensitive ecosystem response and adaptation in the arid and semi-arid northern china	Chen Fahu	Lanzhou University	1,695.80

Funding of Major Program Projects in 2017 (Continued)

No.	Project Title	PI	Home Institution	Direct Funding
17	Impact of ecohydrological process on the feedback mechanism and risk regulation of mountain hazards in the steep terrain regions, eastern Qinghai-Tibetan plateau	Cui Peng	Institute of Mountain Hazards and Environment, CAS	1,695.80
18	Hazard mechanism and catastrophic effect control of disasters caused by mega-engineering in loess plateau	Peng Jianbing	Changan University	1,700.00
19	High-resolution records of paleoenvironmental and paleoclimatic evolution from the cretaceous continental scientific drilling in China	Wang Chengshan	China University of Geosciences (Beijing)	1673.50
20	Airgun crust sounding technology and application	Chen Xiaofei	South University of Science and Technology of China	1,652.00
21	Impact of arctic ocean-ice-air system on wintertime extreme weather and climate events over Eurasian continent	Zhang Renhe	Fudan University	1,649.40
22	Material-structure integrated design and manufacturing for advanced thin-walled aerospace components	Lin Zhongqin	Shanghai Jiao Tong University	1,491.00
23	Integrated optimization of non-equilibrium phase transformation and microstructure based on near-rapid solidification by strip casting	Wang Zhaodong	Northeastern University	1,598.90
24	Multifunctional principles and new coupling effects in perovskites	Li Xiaoguang	University of Science and Technology of China	1,588.00
25	Fundamental research on designing and manufacturing of advanced composites and their structure for large aircraft radial tire	Zhang Liqun	Beijing University of Chemical Technology	1,561.40
26	Fundamental investigation on novel aerodynamic configuration of axial compressor	Sun Xiaofeng	Beihang University	1,566.00
27	Fundamental researches on the generation and modulation of ultra-high power electrical pulse based on directly driven technology	Qiu Aici	Xi'an Jiaotong University	1,560.00
28	The mechanisms of water-saving and salt-controlling and integrated management of irrigation and drainage in agricultural area of northwest of China	Kang Shaozhong	China Agricultural University	1,595.00
29	The fundamental research on ocean target detection and recognition via collaboration of space-borne and airborne sensors	He You	Naval Aviation University	1,798.00
30	Coordinated active safety control and application for vehicles under extreme operating conditions	Li Yuliang	Jilin University	1,739.20

Funding of Major Program Projects in 2017 (Continued)

No.	Project Title	PI	Home Institution	Direct Funding
31	Fundamental theory and key technology for integration of train control and online rescheduling for high-speed railways synthesis of fine chemicals	Ning Bin	Beijing Jiaotong University	1,760.40
32	Basic theories and key technologies of mid infrared lasers based on low dimensional structure antimonide semiconductors	Niu Zhichuan	Institute of Semiconductors, CAS	1,689.40
33	Theories and methods for financial innovation and risk management in the internet environment	Zhang Wei	Tianjin University	1,451.00
34	A research on key issues of accounting, auditing and corporate finance in China context	Wu Shinong	Xiamen University	1,530.90
35	Fundamental science researches on decision-making system of national security management	Fan Weicheng	Tsinghua University	1,500.00
36	The function and mechanism of metabolites and sensing dysregulation in tumorigenesis and development	Lei Qunying	Fudan University	1,492.80
37	Mechanistic study on arachidonic acid-driven small bioactive melacules in pathological myocardial remodeling	Yu Ying	Tianjin Medical University	1,530.00
38	Multi-omics study to reveal the contribution of intestinal dysbiosis in the presence and progression of severe bowel and liver diseases	Li Lanjuan	Zhejiang University	1,511.80
39	Mechanisms underlying neurally-derived visual loss and its restoration	Yang Xiongli	Fudan University	1,471.00
40	Abnormal brain functional regions and connectivities in epilepsy: a multi-modal neuroimaging investigation regions, eastern Qinghai-Tibetan plateau	Gao Jiahong	Peking University	1,485.80

Major Research Plan

Applications and Funding of Major Research Plan Projects in 2017

(Unit: 10,000 yuan)

No.	Project Title	No. of Applications	No. of Awards	Direct Funding
1	Trusted software basic research	1	1	310.00
2	The cognitive calculation of audiovisual information	1	1	745.00
3	Function crystal synthesis preparation	1	1	150.00
4	Study on integration method of unconventional emergency management	5	4	260.00
5	Integrated researches of ecology, and hydrological process in the Heihe River Basin	1	1	207.90
6	Deep sea process and evolution of the South China Sea	1	1	432.50
7	Regulatory networks and molecular mechanisms of malignant transformation of non-controllable inflammation	26	5	840.00
8	Basic algorithms and computable modeling for high performance scientific computing	10	7	1,400.00
9	Multigene mechanism of micro-evolution	35	15	5,723.00
10	The neural loop foundation of emotion and memory	45	16	1,800.00
11	Energy-oriented photoelectric conversion materials	4	2	2,400.00
12	Genetic network analysis of main crop yield traits	13	6	2,498.00
13	Precision measurement physics	30	12	3,100.00
14	The coupling system change of the first-atmosphere in the Tibetan plateau and its global climate effect	26	8	1,752.00
15	Basic theory and key technologies of spatial information network	22	7	3,350.00
16	The regulation mechanism of blood vessel homeostasis and remodeling	118	25	2,200.00
17	The regulation mechanism of non-coding RNA in gene information transmission	242	25	3,470.00
18	End-flow combustion basic research for engine	119	35	3,300.00
19	Organ and regional immune characteristics and diseases	153	21	2,000.00
20	Toxicological and health effects of atmospheric fine particles	167	22	3,200.00
21	The basic research on the causes and coping mechanism of China's atmospheric combined pollution	43	11	3,272.00
22	Catalytic science of carbon-based energy conversion and utilization	168	20	2,350.00

Applications and Funding of Major Research Plan Projects in 2017 (Continued)

No.	Project Title	No. of Applications	No. of Awards	Direct Funding
23	Big data driven management and decision research	238	31	4,783.00
24	Runoff changes and adaptive use of the Weiyuan area in the southwest	73	13	2,640.00
25	Research on fundamental theory and key technologies of fused robot	247	44	5,500.00
26	Degenerative changes based on the mechanism of aging and organ	245	39	3,700.00
27	New light field regulates physical reactions	171	23	4,000.00
28	The hydrosphere biosphere drives earth's elemental circulation mechanism	120	26	3,865.00
29	The formation, evolution and mechanism of turbulent structure	83	24	4,000.00
30	Dynamic modification and chemical intervention of biological macromolecules	293	50	5,350.00
31	Organelle interaction network and its function research	81	23	3,000.00
32	Tethys earth power system	73	16	3,201.00
Total		2,855	535	84,799.40

Joint Funds

Applications and Funding of Joint Funds in 2017

(Unit: 10,000 yuan)

No.	Type of Program	No. of Applications Received	No. of Awards	Direct Funding
1	NSAF Joint Fund NSAF Joint Fund for Basic Physics Research	91	49	6,216.00
2	Joint Fund of Iron and Steel Research	101	26	2,520.00
3	Joint Fund of Astronomy	162	43	3,360.00
4	NSFC-Guangdong Joint Fund	68	23	8,100.00
5	NSFC-Yunnan Joint Fund	171	20	4,090.00
6	Joint Fund of Large Science Facilities	257	76	6,720.00
7	NSFC-Xinjiang Joint Fund	230	54	6,720.00
8	NSFC-Henan Joint Fund	1,288	109	8,400.00
9	Joint Fund of Petrochemical Engineering, Type A	214	18	2,520.00
10	Joint Fund to Promote Cross-Staits Scientific and Technological Cooperation	121	20	4,090.00
11	NSFC-Shandong Joint Fund	316	30	8,400.00
12	Joint Fund for Qaidam Salt Lake Chemical Research	8	3	1,680.00
13	NSFC-GenerTec Joint Fund for Basic Research	136	45	6,720.00
14	Joint Fund of Advanced Aerospace Manufacturing Technology Research	159	27	4,200.00
15	NSFC-Liaoning Joint Fund	30	14	3,500.00
16	NSFC-Zhejiang Joint Fund for the Integration of Industrialization and Informatization	68	21	4,200.00
17	Joint Fund for the Innovation-Driven Development of China Automobile Industry	70	14	3,270.00
18	NSFC-Shanxi Joint Fund for Coal-based Low-Carbon Technology	218	33	4,120.00
19	NSFC-Guangdong Center for Big Data Research	19	7	3,610.00
20	Joint Fund of Civil Aviation Research	184	33	1,680.00
21	NSFC-Shenzhen Robotics Research Center Project	90	24	7,247.00
22	High-Speed Railway Joint Fund	73	11	2,563.00
23	Yalong River Joint Fund	74	17	2,520.00
24	Joint Fund for Smart Grid	230	23	6,720.00
25	Joint Fund for Space Science Satellite	73	53	10,080.00

Part II

Project Review

In 2017, supported by NSFC, a number of research teams made remarkable innovative achievements and major breakthroughs in basic research of various areas (the following is the list of the teams and the introductions of their research achievements).

List of Achievements Made by NSFC-Funded Research Teams

No.	Project Title	PI
1	High dimensional algebraic geometry research	Xu Chenyang
2	DAMPE publishes the most accurate teraelectronvolt cosmic-ray spectrum of electrons and positrons	Chang Jin
3	Large-scale quantum science experiments and quantum networks	Pan Jianwei
4	PandaX-II dark matter detection experiment	Karl Giboni
5	High-resolution multi-functional chemical imaging system	Wan Lijun
6	International molecular ferroelectric research	Xiong Rengen
7	Chemical synthesis of large designer yeast chromosomes	Yun Yingjin
8	Genetic mechanism of soybean adaptation into tropics	Kong Fanjiang
9	The m^6A modulates hematopoietic stem and progenitor cell specification	Liu Feng
10	The interface processes of organic N and P and algal bloom risk of the plateau lakes	Wang Shengrui
11	Digital soil mapping of the Heihe River Basin	Zhang Ganlin
12	Vessel multi-phase electric machine system	Ma Weiming
13	Strengthened micro-interfacial mechanisms and related water purification technologies	Liu Huijuan
14	Management techniques and sediment modeling for the Three Gorges Dam and its downstream reaches	Hu Chunhong
15	Integration and comprehensive verification of key technologies for driverless driving based on visual and auditory cognition mechanism	Mei Tao
16	Trusted software research	Jiang Changjun
17	Theory of accounting information and corporate valuation	Jin Qinglu
18	Effect of consumer behavior in dynamic pricing	Hu Peng
19	Fusobacterium nucleatum promote autophagy-mediated chemoresistance in patients with colorectal cancer	Fang Jingyuan
20	Origin of SARS coronavirus	Shi Zhengli

A major breakthrough made in high-dimensional algebraic geometry research

Algebraic geometry was initiated when people want to use the intuition from geometry to solve polynomial equations. It is now a central topic in mathematics. More concretely, Xu Chenyang conducts research on birational geometry, which centered on the minimal model program. Here birational classification means identify two algebraic varieties after taking out a smaller dimensional subvarieties, and this is one of the most basic classifications. Supported by National Science Fund for Distinguished Young Scholars, Xu made breakthrough in algebraic geometry, especially higher-dimensional geometry. The results were published on top journals like *Journal of AMS*, *Inventiones Mathematicae*.

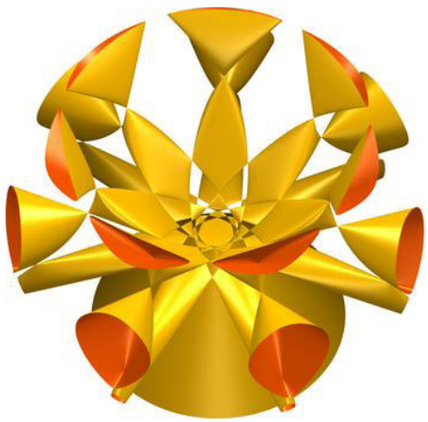


Figure 1. A degree-7 labs septic surface with 99 nodes.

In collabration with Hacon, Xu made crucial progress in the three-dimensional minimal model program in positive characteristics. The minimal model program aims to do operations on any given algebraic variety, and at the end produces a representative which is birational to it and carry canonical properties. Once it was proposed forty years ago, minimal model program became a central question in algebraic geometry. In characteristic zero, Mori and other people finished it, and it won Mori the Fields model. After that, people also achieved important results in characteristic in all dimensions. However, before the work by Hacon-Xu, there was little progress in positive characteristics for dimension greater than 2. Hacon-Xu proved when the characteristic is larger than 5, flips exist in three dimensions. After their work appeared, it was followed by many other mathematicians, and started a new branch in birational geometry. Guided by their work, now people are close to completely finish the three-dimensional minimal model program for characteristic larger than 5.

Xu's another research focuses on singularities. Study on singularities is a main topic in many branches, including algebraic geometry. The minimal model program usually produces singular varieties, therefore investigating singularities is unavoidable in birational geometry. Xu has done a number of works in the topology and geometry of singularities. With de Fernex, Kollar, Xu developed the theory on how the minimal model program modifies the dual complexes. Then with Kollar, Xu established the finiteness of the fundamental group of the dual complex of a log Calabi-Yau pair, and used it solving Kontesvich-Soibelman's conjecture on the dual complex of the maximal degeneration of a Calabi-Yau manifold when the dimension is less or equal to 4. Xu also proved that the algebraic fundamental group of a Kawamata log terminal singularity is finite, and also now is developing the stability theory of such singularities with Chi Li.

DAMPE publishes the most accurate teraelectronvolt cosmic-ray spectrum of electrons and positrons

The dark matter constitutes about 27% of the energy density of the current universe, about 5 times that of the normal matter. Its nature is one of the most outstanding questions in physics and astrophysics. Dark matter particle explorer (DAMPE, also known as Wukong), the first Chinese astronomical satellite, was successfully launched on Dec. 17, 2017. DAMPE was designed based on the particle separation method developed by the scientists from Purple Mountain Observatory. Its cost is much cheaper than other experiments including Fermi-LAT and AMS-02. As a detector optimized to measure cosmic ray electrons and gamma-rays, DAMPE has an unprecedentedly high energy resolution and low background, which are suitable to catch the sharp spectral feature that may arise from dark matter annihilation or decay. The scientific objectives of DAMPE include the probing of the nature of dark matter particles, understanding the acceleration and propagation of cosmic rays and studying the mechanisms of the galactic and extragalactic GeV outbursts.

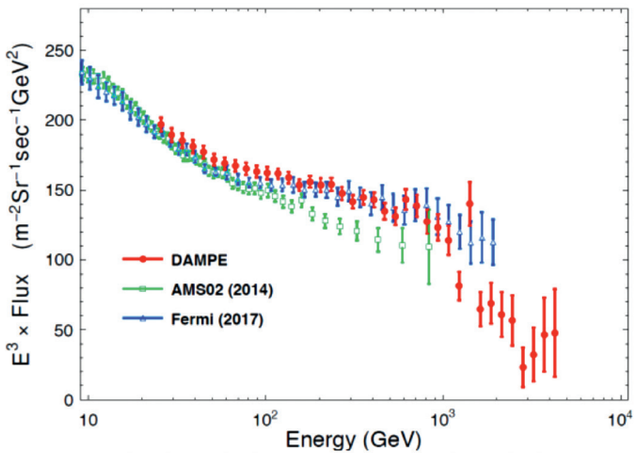


Figure 1. The electron and positron spectrum (in red) measured by Wukong in the first 530 days during its scientific performance. The blue and green points are measured by Fermi-LAT and AMS-02.

Thanks to the support by NSFC and other foundations, the DAMPE collaboration, led by Professor Chang Jin from Purple Mountain Observatory, has obtained the most accurate TeV electron and positron spectrum. The paper has been published in *Nature* with the title of "Direct detection of a break in the teraelectronvolt cosmic-ray spectrum of electrons and positrons". In comparison to the earlier results: 1. The energy range of the DAMPE electron and positron spectrum is wider than the previous ones (including Fermi-LAT and AMS-02), which opens a new observation window; 2. At TeV energies, the electron measurement by DAMPE is distinguished by its unprecedentedly high energy resolution and low background (i.e., the proton contamination is extremely low); 3. DAMPE has directly measured the electron spectral break at ~0.9 TeV, which clarifies the behavior of the cosmic ray electron (CRE) and positron spectrum at energies above 1 teraelectronvolt and sheds light on the physical origin of the sub-teraelectronvolt CREs.

As shown in the figure, there is also the hint for a sharp spike at ~1.4 TeV. More data are definitely needed to explore its nature. Now DAMPE works very well in the space and more data will be available soon. If the tentative signal at ~1.4 TeV is confirmed, it would be a breakthrough on either particle physics or astrophysics.

Breakthroughs made in large-scale quantum science experiments and quantum networks

The research on long-distance quantum communication and the construction of global quantum Internet not only help people to have a deeper understanding of quantum physics, meeting the national demands on quantum information technique, but much more push the developments of fundamental physics and science, therefore making an important step towards the wide-range applications of quantum communication in finance, governmental affairs, national defense, electronic information and so forth. The ultimate goal is to construct a complete national industry chain for quantum communication and a safe ecosystem for the next-generation national sovereignty information, and thus establishing quantum Internet based on quantum security.

Supported by the Science fund for Creative Research Groups, "Quantum information physics and technology based on photons and cold atoms" and National Science Fund for Distinguished Young Scholars, etc., the research team led by Professor Pan Jianwei (CAS member), from the University of Science and Technology of China, has been focusing on the development of photon-based and cold-atom-based quantum manipulation techniques and the exploration of their applications in achieving scalable quantum information processing and revealing the micro-physical mechanisms among complex physical systems with quantum simulation. These include quantum information processing with photons, scalable quantum communication and quantum computing, quantum storage and quantum relay technology based on cold atomic ensembles, quantum simulation based on ultra-cold atoms and optical lattices and so forth. After nearly three years of systematic research on key technologies, a series of internationally advanced results and technology accumulation have been achieved in quantum communication, making the practical applications of quantum communication technology in China at the forefront in the world.

During the funding period, the representative research results obtained in the research direction on large-scale quantum communication include:

1. Full-scale ground-based experimental verifications of key technologies for satellite-to-ground quantum key distribution have been successfully implemented for the first time in the world, laying a solid technical foundation for the future realization of a global quantum network based on satellite-to-ground quantum communication;

2. The first experimental demonstration of quantum key distribution which can tolerate a very

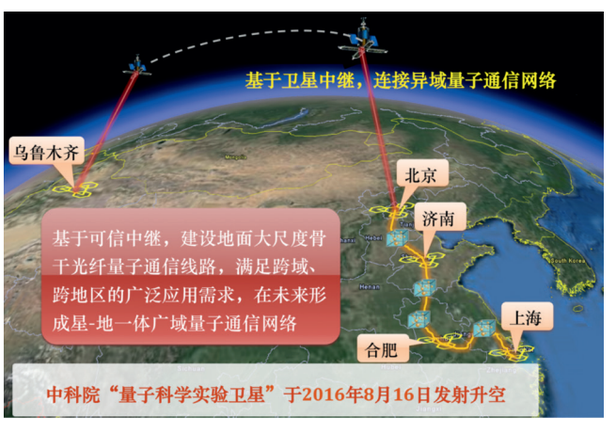


Figure 1. Quantum science and experimental satellite "Mozi".

high quantum bit error rate (up to 29%) over a 50 kilometers optical fiber link;

3. For the first time in the world, the measurement of quantum entanglement-related lower bound of collapse rate without local loopholes was successfully implemented. The result shows that in all inertial reference system, running with one thousandth of speed of light or lower speed relative to earth, the lower limit of the quantum entanglement-related collapse velocity is 10,000 times the speed of light.

These series of important achievements have provided solid technical supports for the successful implementation of strategic precursory project of Quantum Science and Experimental Satellite of CAS, and for the "Beijing-Shanghai Backbone" of the long-distance optical fiber communication backbone network of NDRC. On August 16, 2016, the world's first quantum experimental satellite, "Mozi", was successfully launched. It was the first time in the world to conduct space-scale quantum science experiments and has successfully completed three targeting scientific experiments, i.e., high-speed quantum key distribution, quantum entanglement distribution and quantum teleportation between satellite and ground station. In the end of 2016, the 2,000 km quantum communication link was successfully established between Beijing and Shanghai, which is the world's first backbone of secure quantum communications, achieving the long-distance connection between Beijing, Jinan, Hefei and Shanghai. Based on the "Beijing-Shanghai Backbone" and "Mozi" quantum satellite, a number of important applications have been successfully demonstrated including the first intercontinental quantum video conference between 6 locations: Beijing, Shanghai, Jinan, Hefei, Urumqi (Nanshan land station), and Austrian Academy of Sciences, the real-time trading of Beijing-Shanghai remote enterprise online banking users at Bank of Communications, the Beijing-Shanghai off-site quantum secured data transmission and disaster recovery backup of ICBC online banking, the off-site encrypted transmitting and quantum encrypted video streaming media of Ali credit data, etc. These achievements indicate the feasibility of the global quantum communication network. Such global quantum network not only directly serves the country's strategic needs in the field of communication security in several important environments such as military operations, disaster relief and order maintenance, strengthen the civic-military integration, but also to attract and foster a number of upstream and downstream firms in the field of quantum secure communication, ranging from the manufactures of quantum secure communication equipment and core components, data encryption services and system development, to the construction and operation of secure communication line and other fields. This enables quantum secure communication industry to become the strategic emerging industries of China.

During the project, the research team has published more than 60 research papers including *Nature* (1 article), *Nature Physics* (1 article), *Nature photonics* (3 articles), *Nature Communications* (1 article), *Physical Review Letters* (22 articles) and other international authoritative academic journals of related fields. In addition, the three scientific achievements based on the "Mozi" quantum satellite have been published in *Science* (1 article) and *Nature* (2 articles) as the form of cover story paper and cover headline papers respectively.

Great progress in PandaX-II dark matter detection experiment

The PandaX experiment in CJPL is the first large scale liquid xenon dark matter search experiment in China. The experiment was led by Professor Ji Xiangdong from Shanghai Jiao Tong University (SJTU). The collaboration was started in 2009. The first stage of the experiment (PandaX-I) with 120 kg xenon target was concluded in 2014, releasing a first result with competitive sensitivity, a big step-forward for the Chinese domestic dark matter program. However, PandaX was facing fierce competitions from larger scale experiments such as LUX in US and XENON1T in Europe.

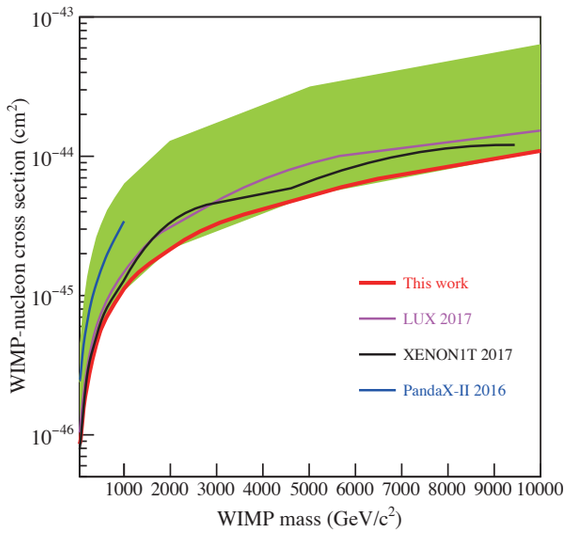


Figure 1. The newest limit (red) on the spin-independent elastic scattering cross section between the WIMP and nucleon obtained by the NSFC project PandaX-II half-ton liquid xenon dark matter experiment in CJPL (PandaX-II), in comparison with other world experiments (pink: LUX; dark: XENON1T; blue: PandaX-II 2016).

The NSFC Emergency Management Project of PandaX-II half-ton liquid xenon dark matter experiment in CJPL, with Professor Karl Giboni from SJTU as the PI, was launched in 2015. The funding was to support the construction and operation of the half-ton PandaX-II detector. Further studies on the detector performance, background characters, signal properties and dark matter models have been supported by NSFC Key Program and National Science Fund for Distinguished Young Scholars, led by Professor Liu Jianglai from SJTU. In the past three years, PandaX-II has made the following important progress:

1. Constructed the first half-ton level liquid xenon dark matter detector, which was the largest dark matter detector with lowest background level in 2015-2016.

2. The experiment commenced to take physics data from March 2016. With a three month dark matter exposure, PandaX-II published its first result in *Physical Review Letters* (*PRL*) as a cover article, also a "*PRL* Editor's Suggestion", and a "Viewpoint" article. This

represented the world best dark matter limit in 2016, surpassing the LUX and XENON1T experiments.

3. PandaX-II published the newest results in *PRL* again in November 2017, with a data set with the largest exposure in the world. This represented the most stringent limit on WIMP-nucleon scattering for WIMP masses larger than about 100 times protons. The paper is again an "Editor's Suggestion" and a "Viewpoint" article.

4. Using these data, scientists carried out studies on spin-dependent scattering, inelastic scattering, and the search for axions. These studies have led to world-leading results.

Based on the above, the PandaX-II experiment sets very stringent constraints to interaction between WIMP and normal matter. In particular, the possibility that the standard model particles acting as the force carrier has been excluded. The new results have strong impact to the international dark matter community. So far, PandaX-II has published 4 papers in *PRL*, three of which are "Editor's Suggestions". The first result in 2016 has been cited by more than 280 times. In view of these outstanding contributions to the field, Ji was invited to write a review article on the dark matter direct detection in *Nature Physics*, which was published in March 2017.

Development of a high-resolution multi-functional chemical imaging system

Chemistry is a fundamental discipline investigating composition, structure, property and reaction of materials. A key problem in the field of chemical research is how to study the structure, property and function of complex materials and systems by in-situ, real-time, molecular-level techniques. To solve this problem, chemical imaging which combines imaging techniques with spectroscopy analysis is rapidly developing in recent years. However, the existing chemical imaging techniques are difficult to realize multimodal characterization of molecular structures and interactions at high spatial and time resolution.

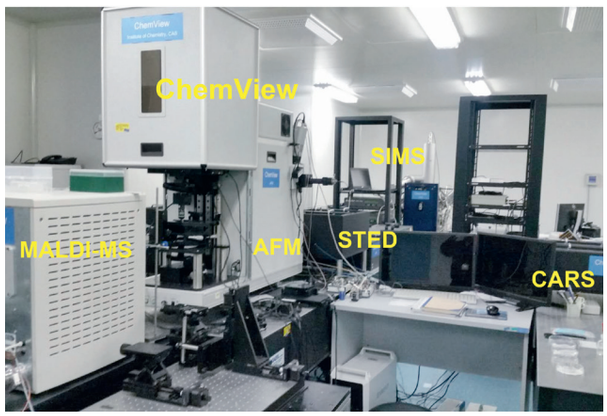


Figure 1. High resolution multi-functional chemical imaging system ChemView.

In January 2012, the project "High-resolution multi-functional chemical imaging system" under the support of the Special Fund for Research on National Major Research Instruments, was launched and led by Professor Wan Lijun from Institute of Chemistry, CAS. The research team was composed of the experts from CAS Key Lab of Molecular Nanostructure and Nanotechnology and CAS Key Lab of Analytical Chemistry for Living Biosystems. The project is aimed to develop a chemical imaging system based on the super-resolution optical imaging, and integrated with the other new chemical imaging techniques, such as scanning probe microscopy, mass spectrometry, etc. The system cannot only characterize the morphology and chemical composition of the materials, but also provide in situ, real-time, multi-parameter quantitative information on the structures, molecular interactions and dynamic change of materials at the molecular level. After more than 5 years of collaborative hardworking, the project has been completed successfully. In June 2017, the project team has passed the on-site examinations organized by NSFC including technical specifications, as well as technical files, financial audit and others. The key achievements of the project include:

The imaging system ChemView has been successfully built. The system is composed of multiple modules such as stimulated emission depletion microscopy, coherent anti-

Stokes Raman spectroscopy, scanning probe microscopy, MALDI mass spectrometry with confocal microscope based excitation, and secondary ion mass spectrometry imaging. These modules can work independently, and collaboratively to realize the characterization of morphology and chemical composition of complex systems at the nano-scale and molecular level.

During the process of instrument development, a number of key technical breakthroughs have been made. For example, 5-dimensional and 7-dimensional beam alignment techniques have been invented for STED and CARS imaging respectively; remote sample transportation and ionization method has been developed for ambient mass spectrometry based imaging; high quality TERS/TCARS tips and multimodal fluorescent probes have been developed; in-situ liquid secondary ion mass spectrometry technique has been developed, and so on.

The development of the chemical imaging system offers a new platform to study the structure and function of energy materials and biological systems. And a series of innovative results have been obtained. For example, by using the ChemView system, the morphology and chemical composition of the key electrode materials in high energy density lithium batteries has been revealed, real-time characterization of the dynamic change of cell signaling proteins has been realized; the specific proteins responsive to drug-damaged DNA has been identified; and quantitative trace analysis of carbon nanotubes in the biological system has been achieved.

The project has filed 46 Chinese invention patents, 4 international PCT patents, and 18 invention patents have been authorized. The research team has published 167 scientific papers in peer-reviewing journals, including *Nature* series, *J. Am. Chem. Soc.*, *Angew. Chem.*, etc. The successful development of multi-functional chemical imaging system has not only realized the innovation of chemical imaging technology, but also provides new tools in the field of energy chemistry and life chemistry.

Researchers in Southeast University lead international molecular ferroelectric research

It has been about one hundred years since the first discovery of molecular ferroelectrics (MFe). The great potential in fundamental study and practical applications of MFe have attracted tremendous interests from researchers all over the world including several Nobel Laureates. In 2007, Professor Xiong Rengen founded the Ordered Matter Science Research Center (OMSRC) in Southeast University. Since then, researchers in OMSRC have been dedicating themselves to the development of molecular ferroelectrics and obtained many achievements with the great support from NSFC.

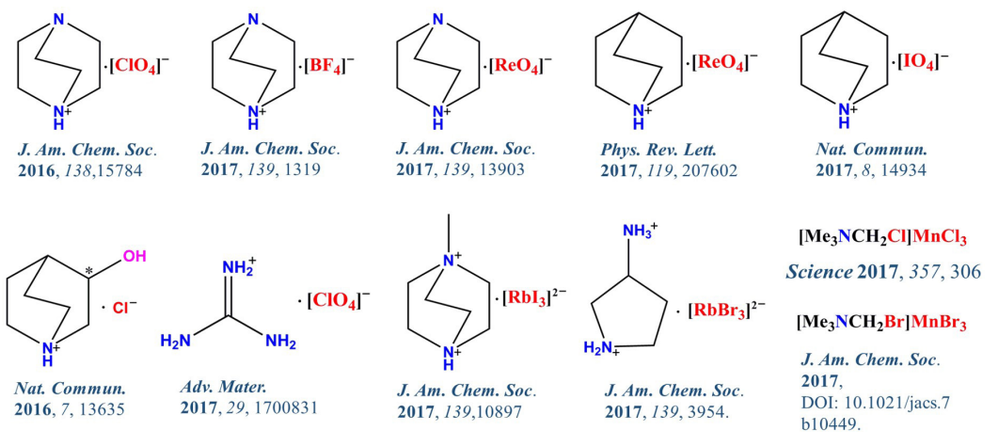


Figure 1. Summary of multiaxial MFe recently discovered by researchers in OMSRC.

Supported by NSFC, researchers in OMSRC focus their studies on key problems hindering the future application of MFe. Since 2015, the improvement of the low piezoelectric responsibility and bad thin-film performance has been their priority. Their major achievements include:

1. First-timely synthesis of MFe with giant piezoelectric coefficient d_{33}. In 1880, the brothers of Curie discovered piezoelectric effect. After that, more than 100 years have passed, and none of molecular material has piezoelectric performance comparable to that of inorganic materials. To tackle such a problem of the century, the research team in OMSRC designed MFe with multiple polar-axes, such as $Me_3NCH_2ClMnCl_3$ (TMCM-$MnCl_3$), $Me_3NCH_2ClCdCl_3$ (TMCM-$CdCl_3$) and $Me_3NCH_2BrMnBr_3$ (TMBM-$MnBr_3$). Those materials owe

superior d_{33} much larger than that of any reported MFe, reaching 185 pC/N (TMCM-$MnCl_3$) and 220 pC/N (TMCM-$CdCl_3$), which are even comparable to that of inorganic ceramics such as BTO. Related works have been published by top-notched peer-reviewed journals such as *Science* and *J. Am. Chem. Soc*.

2. Synthesis and tuning on multiaxial molecular ferroelectrics. The team in OMSRC has found that the bad thin-film performance is closely related to the mono-axial properties of MFe. Thus, they firstly developed a semi-empirical solution to obtain MFe with multiple polar axes. Until November 2017, The team in OMSRC has synthesized various multiaxial MFe, including: tetraethylammonium perchlorate with the most reported number of polar-axes (twelve fold), Hdabco-ReO_4 with the highest Curie temperature (499.6 K) and fastest polarization switching speed (100 kHz), quinuclidinium periodate thin-film with no substrate-dependency, cold-pressed guanidinium perchlorate powder-pellet with decent ferroelectricity, etc. Their works have been published on various major peer-reviewed journals including: 1 paper in *Science*, 1 paper in *Phys. Rev. Lett*, 5 papers in *J. Am. Chem. Soc*., 1 paper in *Adv. Mater.*, 2 papers in *Nat. Commun*., etc.

After more than ten years' endavour, with the great effort of the research team in OMSRC, key ferroelectric properties of MFe have become comparable to those of inorganics. Their recent achievements open a promising pathway for other research teams in both material science and technology and certainly a tremendous leap ahead. This also marks that Chinese researchers have once again led the international study on molecular ferroelectrics.

A milestone breakthrough achieved in the chemical synthesis of large designer yeast chromosomes

Following the discovery of the DNA double helix structure and the advancement of genome sequencing, we have entered a promising stage with regard to genome writing by synthetic biology. The *de novo* synthesis of designer genomes offers an opportunity to rebuild genome organization, remold biological functions and promote life evolution. The achievement of chemically synthesized genomes by synthetic biology provides new technologies and approaches for solving major problems of resources, energy, health, environment and security, which will be of great benefit for fostering global economic growth.

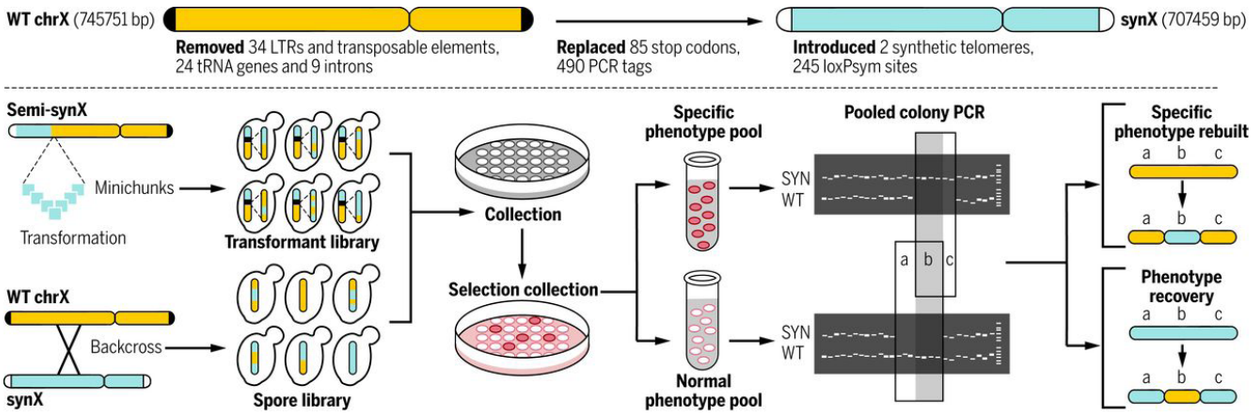


Figure 1. Pooled PCRTag mapping approach.

The project "synthetic biology and biological processing" funded by the Science fund for Creative Research Groups is led by Professor Yuan Yingjin of Tianjin University. Aiming to seize strategic high ground of international synthetic biology, the project is focusing on the fundamental research of designer genome synthesis and accurate reconstruction of artificial cell factory. The construction of artificial cell factories will be of great benefits for biological processing strengthening, energy conservation and efficient use of abandoned resources, and promoting the industrialization of important pharmaceuticals, energy and chemicals. The achievement of genome synthesis and artificial cell factory construction will train a batch of strategic science and technology talents, leaders and young scientists, promote the development of synthetic biology in China, and form an international research center of synthetic biology.

Recently, a milestone breakthrough was achieved by this group in the chemical synthesis of designer yeast chromosome V and chromosome X from scratch. The major innovations are as follows:

1. Yeast chromosomes were designed and *de novo* synthesized from chemical synthesized nucleotides by developing hierarchical chromosome assembly strategies. The physical sequence of initial chromosome V was corrected the assembled to perfectly match the specified designed sequence using integrative cotransformation and clustered regularly interspaced short palindromic repeats (CRISPR)-associated protein 9 (Cas9)–mediated genome editing, which is crucial important for the systematic evaluation of underlying design principles.

2. Customized yeast ring chromosome V derivatives were constructed, which are fully functional in *Saccharomyces cerevisiae* under all tested conditions. Within the ring chromosomes, hundreds of distinguishable PCRTags can be used to easily track the chromosomal changes during meiosis and mitosis. Ring chromosomes can extend the design principles to provide a model with which genomic rearrangement, ring chromosome evolution, and human ring chromosome disorders can be studied. Such designer organisms could be exploited as models to comprehend human diseases, identify disease targets, and generate therapeutics.

3. A high-throughput mapping strategy called Pooled PCRTag Mapping (PoPM) was developed to identify unexpected bugs during chromosome assembly. With this method, the genotypes of pools of colonies with normal or defective fitness are assessed by PCRTag analysis. PoPM is a powerful tool to map interesting phenotypes of mutated synthetic strains and even mutated wild-type strains to the relevant genes.

Two papers were published in the same issue of *Science* on March 10, 2017 based on above innovations, which were highly evaluated by experts in top journals, including *Science*, *Nature*, *Nature Biotechnology*, *Nature Reviews Genetics* and *Molecular Cell*.

Breakthrough made on the genetic mechanism of soybean adaptation into tropics

Cultivated soybean was domesticated in Huanghuai Region in north China. After long time adaptation and artificial selection, soybean had been cultivated in tropical regions. Varieties from temperate regions introduced to lower latitudes typically flower and mature very early, and as a consequence grain yield is extremely low. However, introduction of the long juvenile (LJ) trait, which extends the vegetative phase and improves yield under short day conditions, has largely overcome this constraint and enabled a major expansion of soybean cultivation in tropical regions.

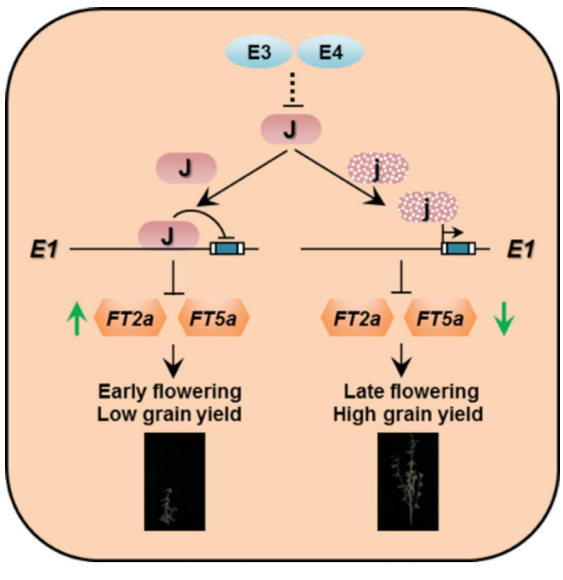


Figure 1. Molecular model of *J* regulated-flowering and yield formation. *E3E4* partially down-regulate the expression of *J*. *J* protein physically binds the promoter of *E1* gene to down-regulate is expression to relive the transcription of *FT*, to promote flowering and reduce grain yield.

Under the support of NSFC, Professor Kong Fanjiang's group from Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences had map-based cloned and functional characterized of *J*, the major classical locus conferring the LJ trait. The findings discovered that *J* gene was the soybean orthologue of Arabidopsis *ELF3*, and identified variation at *J* as the molecular basis for the adaptation and enhancement of grain yield in tropics. The effects of *J* depend genetically on *E1*, a key legume-specific repressor of flowering, and the *J* protein associates physically with the *E1* promoter to down-regulate its transcription, relieving the *E1*-dependent repression of two important *FT* genes that are targets of *E1*, and promoting flowering under short day (SD) conditions (Figure 1). The loss-of-function allele of *J* can increase soybean grain yield up to 30%–50%. These findings identify an important new component in the mechanism for flowering time control in soybean and give new insight into an adaptation of major significance for soybean production in tropical regions.

The findings were published in 2017 in *Nature Genetics* and had been highlighted by famous journals such as *Nature Plants* and *Chinese Bulletin of Botany*.

m^{6}A modulates hematopoietic stem and progenitor cell specification

Hematopoietic stem cells (HSCs) are the only cells with the capability to self-renew and differentiate into all blood lineages. The limit of the donors to provide sufficient HSCs in the clinic makes it urgent to produce HSCs ex vivo or in vitro in regenerative medicine. After decades of studies in this field, by using animal models from zebrafish, frog, chicken to mouse, scientists have achieved some basic understanding about developmental hematopoiesis in vivo and have tried to recapitulate it in vitro to some extent. However, the detailed regulatory mechanism underlying this cell fate change during endothelial to hematopoietic transition (EHT) is still largely unclear, especially for the role of epigenetic modification in this process. N6-methyl-adenosine (m^{6}A) is one of the most prevalent mRNA modifications in eukaryotes. Recently, a series of seminal studies have begun to reveal its important functions including the maternal-to-zygotic transition in zebrafish, sex determination in drosophila and T cell homeostasis in mouse. However, the physiological functions and regulatory mechanism of m6A modification, especially during embryogenesis in vertebrates still remain elusive.

In collaboration with Professor Yang Yungui from Beijing Institute of Genomics, the Hematopoietic and Cardiovascular Development Group led by Professor Liu Feng utilizes zebrafish to study the role of epigenetic modification in embryonic HSC development.

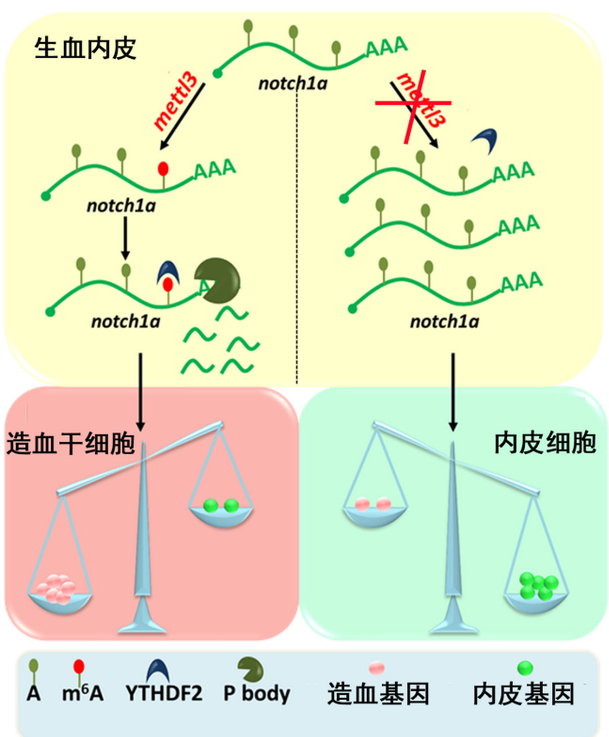


Figure 1. Schematic representation of the role of m^{6}A methylation in HSC fate determination during EHT via METTL3-notch1a.

1. Identify the m^{6}A methyltransferase complex in zebrafish (*Cell Res*., 2014).

2. Find that the m^{6}A enrichment on embryonic development-related mRNAs was significantly decreased upon the loss of *mettl3* by m^{6}A-Seq in zebrafish embryos.

3. *mettl3* is specifically expressed in the hemato-vascular systems in zebrafish embryos. Upon *mettl3* depletion, the endothelial cell fate was enhanced, but the EHT was blocked, thereby leading to the failure of HSC generation.

4. Bioinformatics analysis of m^{6}A-Seq and RNA-Seq revealed that the m^{6}A modification on a series of arterial endothelial cell related genes, especially *notch1a* mRNA, was decreased, while their mRNA levels were increased.

5. The YTHDF2-RIP-Seq and single-nucleotide resolution m^{6}A-miCLIP-Seq demonstrated that YTHDF2 mediates m^{6}A-modified *notch1a* mRNA stability, supporting that m^{6}A functions as a rheostat to maintain the balance of gene expression between endothelial cell and HSC during EHT.

6. In mouse, endothelial-specific *mettl3* facilitates m^{6}A methylation on *Notch1* mRNA to inhibit Notch activity in HE cells, thereby promoting HSC generation through EHT. These results are consistent with recent findings in zebrafish.

This study, for the first time, uncovers the regulatory mechanism of m^{6}A mRNA methylation in vertebrate hematopoietic stem cell fate determination, and also provides useful insights to the *in vitro* generation of HSCs for clinical application. The papers were published in *Nature* and *Cell Res*.

Important progress made about the interface processes of organic made P and algal bloom risk of the plateau lakes

The research on the bioavailability of dissolved organic nitrogen (DON) in lakes and its impact on algal blooms is still in initial stage, which is specially needed to investigate for lakes in Yunnan Plateau due to their unique geographical location and climatic characters. The researches about these aspects include the main transfer-transform mechanism of DON and dissolved organic phosphorus (DOP) at lake interface, the comprehensive characterization of their bioavailability and the influence on the algal bloom risk. Those are the key scientific problems needed to be answered to reveal the mechanism of plateau lake eutrophication.

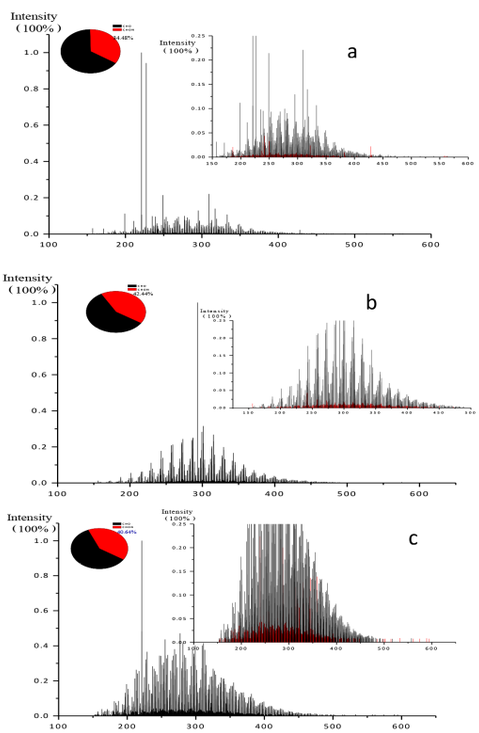


Figure 1. FT-ICR-MS spectrum of DON of the sediment in Lake Erhai. (a) north; (b) middle; (c) south.

Lake Erhai, Lake Dianchi in Yunnan Plateau and the lake interfaces (atmosphere-water, sediment-water and water-organism (algae)) were chosen by the research team of Professor Wang Shengrui from Beijing Normal University based on the support of NSFC-Yunnan Joint Fund, the researches about the DON, DOP processes in plateau lake interfaces and their impacts on algal bloom risk have been performed.

Based on the multi-kind techniques-methods such as flourier-transform ion-cyclotron resonance mass spectrometry (FT-ICR-MS), fluorescence, ultraviolet, infrared spectrum and gas chromatograph-mass spectrometer (GC/MS), the composition and structure of DON in sediments of the Plateau Lake were investigated. For the sediment from Lake Erhai, the portion of DON with the molecular mass larger than 1 KDa accounts for 80% of total DON and it mainly consists of the humic-like substance and the simple aromatic protein. Most DON compounds in sediments (Lake Erhai) with one nitrogen atom and

the high O/N ratio (≥3), which are mainly oxidized nitrogenous functional groups, occupy 75% of the total nitrogenous compounds. The contents of aromatic compounds with the high degree of condensation and the saturated hydrocarbons increase with the depths of sediment profile. The organic nitrogen released from the sediments of Lake Erhai contains a lot of the easily degradable nitrogenous matter, which demonstrates their relative high algal bloom risk. This research finding systematically realizes that the DON composition character of the sediments from Lake Erhai in Yunnan Plateau elucidates the micro-mechanism of DON and DOP transfer at micro-interface of sediment-water at molecular level.

Based on DGT (diffusive gradients in thin films) technique, the multi-elements of P, S and trace metals are measured simultaneously for the research of element transfer at sediment-water interface in Plateau Lakes. DGT profiles of P/Fe/S (-II) and two dimension images of Fe and S (-II) can be gained, which indicated that the DGT measurement accuracy is improved by 50% and the release mechanism of P/Fe/S (-II) in sediment microzone can be investigated at the high spatial resolution (<100 μm). Those investigations innovate the research method of the interfacial microzone of sediment-water in lakes. Moreover, it has been applied to gain the "in-situ" dynamic uptake curve of P and trace metals in macrophyte rhizosphere, to predict P accumulation in macrophyte root tissue and to reveal its dynamic uptake mechanism. It also aids the possibility of the evaluation of the efficiency of ecological restoration using aquatic macrophytes in lakes from the view of the N and P purification.

The above outcomes have been published in *Environ. Sci. Technol.*, *Water Research*, *Journal of Hazardous Materials* and *Environmental Pollution* and so on, which contribute to the further realization of the composition of DON, DOP and their characters of the biogeochemistry processes in plateau lakes, and also have an important values in the fields of the realization of lake eutrophication mechanism and eutrophication control for Chinese lakes.

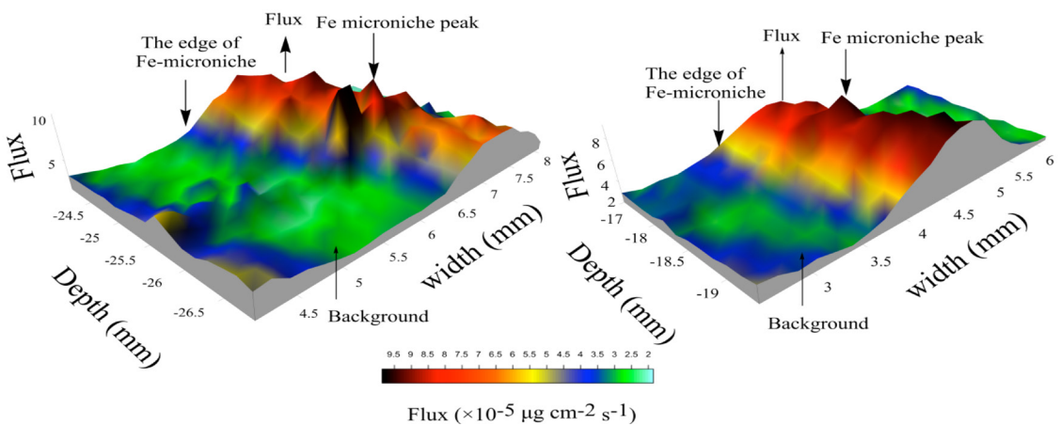


Figure 2. 2D images for Fe-microniche distribution of the sediment microzones in Lake Dianchi.

Significant progress made on the digital soil mapping of the Heihe River Basin

Digital soil mapping is one of the most important frontiers of the soil geography. Soil information with high accuracy is very scarce and fragmented at global or regional scale. The modeling of the eco-hydrological processes in the Heihe River Basin (HRB) is greatly restricted by the low accuracy and coarse resolution of the legacy soil maps.

Therefore, National Natural Science Foundation of China granted a Key Project entitled "Predictive mapping of key soil properties over the Heihe River Basin" in January 2012, which was led by Professor Zhang Ganlin of the Institute of Soil Science, Chinese Academy of Sciences. This project aimed to develop digital soil mapping (DSM) methods and to produce a series of high resolution soil maps of HRB for various purposes. The main progress is summarized as follows:

1. The characteristics of soil evolution and soil variation in space were systematically observed. The dominant forming process within different landscape units in the HRB and their co-evolutionary relationships with regional ecosystems were systematically revealed. The soil-landscape knowledge of the HRB was quantitatively parameterized for the first

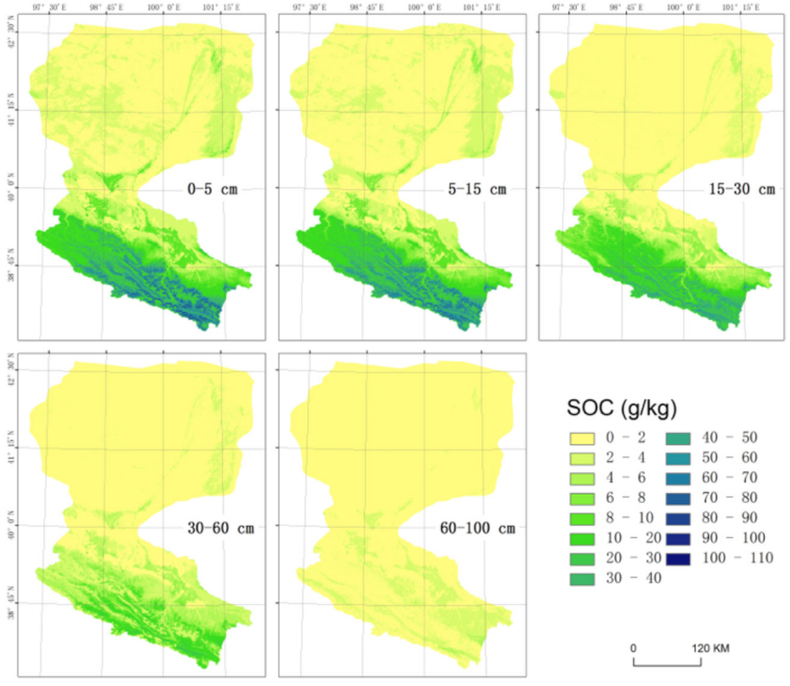


Figure 1. Three-dimensional SOC maps of the Heihe River Basin produced by the project.

time, which not only directly reflected the variation patterns of different soil properties at the regional scale, but also provided the basis for digital soil mapping. Based on the correlation analysis of the variation of critical soil properties and the key indices of soil eco-hydrological function, the functional evolution of loess-derived soils in various environments was identified. Furthermore, it was illustrated that the accumulation of soil organic matter significantly influenced the establishment and functioning of alpine ecosystems and the resulting "mattic epipedon" had a profound impact on the soil hydrological process.

2. The hydrological characteristics of soils in the HRB were systematically analyzed and the set of the soil hydrological parameters was established. Spatial variation of soil hydraulic conductivity was analyzed based on the in situ measurements and soil parameters related to soil moisture characteristic curves were determined. The effects of different kinds of crust on soil infiltration rates were also revealed. The water-stable aggregate in the middle reaches was simulated by incorporating soil properties and environmental predictors. The spatio-temporal distribution of soil moisture was simulated by a deep learning based Cellular Automata, which acted as a basis for the regional mapping of key soil hydrological parameters in the HRB.

3. A series of predictive models for digital soil mapping was established which enabled the predictive mapping of entire watershed. Based on that high resolution soil map products of multiple key soil properties were generated. Soil mapping techniques including classical statistics, geo-statistics and machine learning were studied and improved. Based on the similarity of environmental information and re-weighting of predictors, the accuracy of generated soil types maps of soil group and soil sub-group was increased to 85% and 75%, respectively. The accuracy of predicted soil depth map was 74%. We also improved the 3D soil mapping techniques and applied on key soil properties. Based on the linear hybrid model and artificial intelligence, a series of soil maps in 3D were produced, such as soil organic carbon content, soil texture, and pH and so on.

Based on the above-mentioned research, soil maps of HRB were produced according to the Global Soil Map specifications and were widely utilized in the Major Research Plan of the Integrated Research on the Eco-hydrological Process of the Heihe River Basin. These soil maps not only served the ecological and hydrological process modeling in the HRB, but also made an important supplement to the Global Soil Mapping dataset. The project has published more than 30 papers in international peer-reviewed journals, obtained national invention patents, registered 2 software copyrights, and organized the "6th Global Digital Soil Mapping Workshop" on November 11–14, 2014, in Nanjing, China.

A major breakthrough made in vessel multi-phase electric machine system

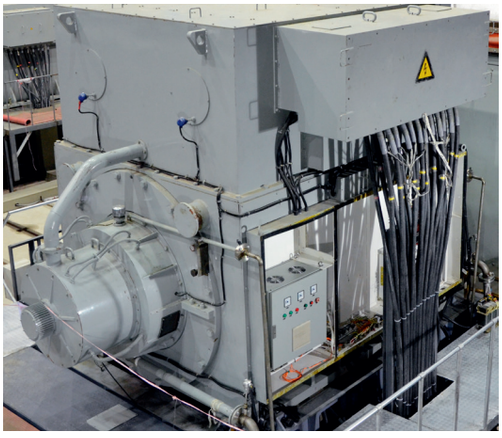


Figure 1. High-power medium-voltage DC generator.

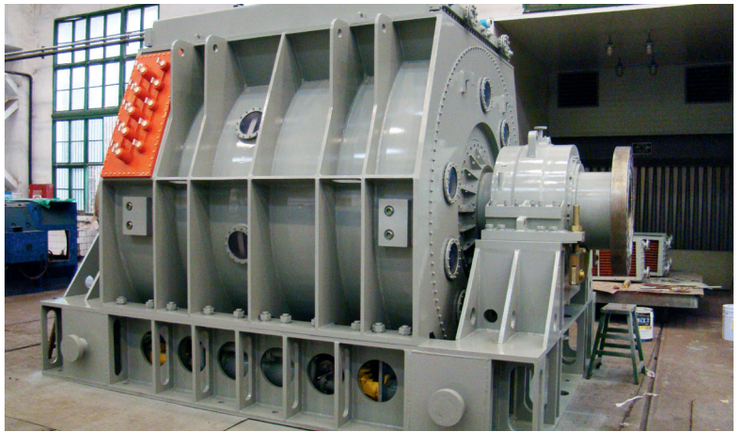


Figure 2. New-type high-power propulsion motor.

The vessel integrated power system (IPS) is a new-type power system integrating the propulsion system and the power generation system in the form of electric energy, both of which are independent in traditional vessels. Known as "the third revolution" of vessel power system, IPS achieves the comprehensive utilization of onboard power and greatly enhances vessel performance. The power generation module and the propulsion module, whose cores are made of high-performance vessel electric machine systems (EMS), are two vital components of the IPS. Performance requirements of modern vessels such as high maneuverability, excellent acoustic stealth, and high reliability, along with the reality of constrained cabin space, request that vessel EMS must feature high power (torque) density, high efficiency, high reliability and low vibration and acoustic noise. However, traditional three-phase EMS cannot achieve the above requirements. Multi-phase design, on the other hand, not only improves the power (torque) density and the reliability of the EMS but also reduces its loss and vibration, representing the trend of high-performance vessel EMS development.

Professor Ma Weiming from Naval University of Engineering put forward the technology route of the medium-voltage DC IPS for the first time in the world. With the support of NSFC, under the guidance of Professor Ma and Professor Wang Dong, systematic studies on the high-performance vessel multi-phase EMS have been carried out, which include the precise modelling of electromagnetic material property, precise and computationally efficient electromagnetic design method, high-performance motor control algorithm, and high efficiency electric machine cooling design. The research is targeted to achieve the overall breakthrough in high-performance vessel EMS from the basic theory to key technologies, and finally

to engineering implementation, providing theoretical guidance and technical support for the development and application of the high-performance multi-phase EMS. The research effort of the team across a time span more than a decade has resulted in several major advances as follows:

1. Established a database of soft magnetic materials covering electrical, magnetic and thermal properties for EMS; proposed a multi-factor dependent model of soft magnetic material properties, fulfilling a leap from qualitative analysis to quantitative analysis taking the nonlinearity and coupling properties of soft magnetic materials into account.

2. Proposed a method for electric machine analysis based on the distributed magnetic circuit, resolving the long-term compromise between computational efficiency and analysis precision; realized wide-range scan of electromagnetic design parameters, laying down the solid foundation for electric machine design optimization.

3. Based on the proposed precise soft magnet models, realized transient bidirectional coupling calculation between electromagnetic and temperature field; found a solution to the significant computation error in the traditional unidirectional coupling calculation, providing support for the accurate analysis of strong coupling characteristics in the high-performance EMS.

4. Established the mathematical model of the multi-phase electric machine fed by non-sinusoidal variable-frequency drive system, extending the design and control theory of the high-performance multi-phase EMS.

5. Proposed a forced-circulation evaporative-cooling technique. Established a flow resistance matching design method and an accurate temperature field simulation model, which solved the problem of the quantitative analysis and design of such cooling methods.

Based on above research achievements, Professor Wang and his research team have successfully developed the medium-voltage high-power high-torque-density propulsion system, and high-power-density integrated generator system, giving a strong support to the application of the mid-voltage DC IPS in China's vessels. The team has won the first prize of the 2017 National Science and Technology Progress Award for the invention of "vessel medium-voltage IPS system".

Important progress made towards strengthened micro-interfacial mechanisms and related water purification technologies

Disinfection by-products (DBPs) and trace persistent organic pollutants (POPs) are commonly found in drinking water and various water sources all over the world. They directly pose a significant threat to human health, since the drinking water safety of roughly 1 billion people can be affected by hazards linked to many DBPs and POPs pollutants. In addition, the discharge of highly toxic inorganic wastewater represents another serious threat to eco-environmental safety. These pollutants are usually highly toxic, harmful, widely distributed and difficult to be treated. Therefore, contaminant control of DBPs, POPs and inorganic pollutants have become one of the major problems in the field of environmental engineering.

Figure1. Practical engineering equipment for chromium-contained wastewater treatment.

At the Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Professor Liu Huijuan carried out a five-year scientific research plan with support from the National Science Fund for Distinguished Young Scholars. This research mainly focused on strategies of controlling aluminum speciation, molecular orientation and ion complexation. By studying the micro-interface processes and related principles of water purification, significant breakthroughs were achieved. Including, the strongly improved formation of preferential species during coagulation, increased active sites for adsorption and the promoted formation of reactive species for redox reactions. A series of new functional materials and new technologies were explored, which were further used in large-scale engineering applications. Their research provides a feasible way to resolve the technical challenges in treating DBPs, hydrophobic POPs and toxic inorganic contaminants (such as Cr) in water. The following progress has been made in the strengthened micro-interfacial mechanism and the related water purification technologies:

1. Based on the strategy of aluminum speciation control around adsorption-coagulation micro-interfaces, technologies for DBPs control have been developed. It was found that preferential Al_{13} species could be formed in-situ on the surface of aggregates under appropriate pH value. Based on the coagulation effect of *in-situ* formed Al_{13} species and the adsorption effect of new formed $FeO_x(OH)_y$ around

strengthened micro-interfaces, a synergetic technology was developed for water purification. The large-scale engineering application of this principle was thereafter achieved. The removal ratio of COD_{Mn} was increased by 20%, and the formation of DBPs was efficiently inhibited. This research provides a feasible way to resolve the technical challenges in simultaneous removal of DBPs and COD_{Mn} for meeting the required water standard.

2. Based on the molecular orientation control around adsorption-accumulation micro-interfaces, technologies for the removal of trace hydrophobic organic compounds have been developed. A synergetic adsorption mechanism was put forward, in which adsorbates were accumulated along the pore walls and were adsorbed within the particle and on the external surface. Several types of functional adsorption materials have been developed, such as biomimetic lipid triolein and magnetic silica aerogel. They further designed lipid triolein-based devices for water purification. These devices exhibited 2,000~20,000 times higher accumulation of POPs, leading to high removal ratio above 90% for dieldrin. As a result, this research provides a new route for the purification of drinking water.

3. Based on the strategy of ion complexation control around adsorption-separation micro-interfaces, technologies for the advanced treatment of highly toxic inorganic compounds have been developed. The principles for the strengthened removal of toxic inorganic contaminants were firstly established by controlling the valence state and existing form of ions. New technique of electrochemical reduction-assisted biological adsorption was successfully used for the treatment of wastewater contaminated by high-valence heavy metals. Therefore, this research broke through the bottleneck of advanced treatment of highly toxic inorganic contaminants at low cost. After treatment, the water quality of chromium contained wastewater could meet the required standard.

This project has already received twenty national invention patents, a second prize of National Technological Invention Award, a first prize of ministerial and provincial-level award. 85 SCI papers have been published, and the impact factors of 22 papers are above 5. The other citations by SCI of these papers are 1,854 times. Based on these technology inventions, 6 complete sets of water treatment equipment have been developed, such as multistage fluidized-bed and activated coke adsorption column. Based on the strengthened micro-interfacial mechanism, such as aluminum speciation control during adsorption-coagulation process, 8 water purification technologies are explored. These technologies have been applied in more than 60 practical engineering projects for water purification, industrial waste water and domestic sewage treatment.

Major advances made in management techniques and sediment modeling for the Three Gorges Dam and its downstream reaches

Figure1. The Three Gorges Dam and its downstream reaches.

Since 2003, storage of water by the Three Gorges Dam has provided immense benefits in flood defense, hydroelectricity, shipping, and water resource usage. However, in recent years circumstances have changed and some new issues have arisen due to significant changes in water and sediment inflows to the reservoir, intense erosion of downstream reaches, and the effects of the dam on Dongting and Poyang Lakes. In addition, Chinese government is currently in the process of promoting the development strategy for the Yangtze River economic belt and constructing the Yangtze River "golden waterway", thus placing ever greater demands on operation of the Three Gorges Dam. In view of the new water and sediment characteristics of the Three Gorges Dam, there is an urgent need to investigate sediment modeling and dam management techniques. Such studies are necessary for ensuring the long-term safety of operation of the Three Gorges Dam, and for extending the overall benefits of the dam under novel water and sediment conditions.

Therefore, with the support of the National Science Fund for Distinguished Young Scholars, Professor Hu Chunhong (China Institute of Water Resources and Hydropower Research, IWHR), Professor Li Danxun (Tsinghua University), Professor Lu Yongjun (Nanjing Hydraulic Research Institute, NHRI), and others have focused their efforts on addressing these issues. They have attained a number of notable scientific achievements:

1. A model for predicting the inflow of sediments to the reservoir has been constructed, and a new water and sediment series for inflows to the Three Gorges Dam has been proposed. Changes in inflows to

the dam have been studied, from which a new water and sediment series has been proposed. This work has laid the foundation for accurate predictions of siltation near the dam, long-term operation of the reservoir, and extension of the benefits provided by the dam.

2. Sediment transport patterns in the Three Gorges Dam and its downstream reaches have been revealed. The flocculation mechanisms of sediment in the dam, and mechanisms of secondary riverbed coarsening due to clear water scouring by the reservoir, have been revealed for the first time. In addition, the relationship between the evolution of typical shoals in downstream reaches and regulation of flow and sediment by the dam has been evaluated, as have changes that have occurred in the relationship between the Yangtze River and Dongting Lake.

3. One-dimensional (1D), two-dimensional (2D), and three-dimensional (3D) flow and sediment mathematical models have been constructed, which have improved the accuracy and sophistication of current state-of-the-art simulation techniques. These models have helped to resolve the bottleneck problem limiting the accuracy of water and sediment mathematical model simulations. This has greatly improved simulation accuracy, and provides an advanced and reliable tool for addressing siltation in large-scale water conservancy projects.

4. Management techniques have been proposed for sediment control and multi-objective optimization of the Three Gorges Dam, as a result of a systematic study conducted on dynamic changes in flood-limited water levels, compensatory operation at Chenglingji Hydrological Station, the impoundment of water in advance, and sediment peak regulation. This study represents a breakthrough in addressing the siltation problem that has constrained operation of the Three Gorges Dam. The findings of this study can also optimize clear water storage with simultaneous discharge of turbid water during dam operation, thus providing a scientific and technological cornerstone of efficient operation of the Three Gorges Dam.

5. New technologies for the regulation of waterways and management of Poyang and Dongting Lakes have been developed. Two new types of structural technology for waterways regulation have been invented: permeable and stepped dam heads. Furthermore, management schemes for typical river waterways in the downstream reaches of the dam have been proposed. Application of the findings of this project has brought about immense socioeconomic benefits, and provided management techniques and theoretical support for the resolution of siltation problems in large-scale water conservancy projects.

They have obtained 8 National Invention Patents, 1 Utility Model Patent, and 5 software copyright licenses, as well as published 128 papers and 5 monographs. They also received First Prize in the 2017 Dayu Water Conservancy Science and Technology Award.

Important progress made in integration and comprehensive verification of key technologies for driverless driving based on visual and auditory cognition mechanism

The integration and verification of key technologies for unmanned driving has a wide range of military and economic application prospects. It is a disruptive technology that changes the way of future travel. It has had a huge impact on society in recent years. The best experimental platform for improving the computer's understanding of unstructured audiovisual perception information and the processing efficiency of massive heterogeneous information when the driverless vehicle has natural environment perception and intelligent behavior decision ability.

Figure1. An electrical driverless car developed under the NSFC Major Research Plan "Integration and comprehensive verification platform of key technologies for driverless driving based on visual and auditory cognition mechanism".

In this respect, NSFC launched an Major Research Plan integration project, "Integration and comprehensive verification platform of key technologies for driverless driving based on visual and auditory cognition mechanism" in January 2014. The project is led by Professor Mei Tao of the Hefei Institutes of Physical Science, Chinese Academy of Sciences. Addressing some key questions for the basic scientific issues such as the perception and understanding of the natural environment of unmanned vehicles in the normal traffic environment of urban roads and intercity highways, intelligent decision-making and autonomous control, the project develops innovative and comprehensive integration as well as experimental verification studies that integrating theory, key technologies, engineering optimization, and road experiments. The project has made important progress in the integration and comprehensive verification of key technologies for unmanned driving as follows.

1. A large-scale traffic scene perception method based on bionic vision was proposed, and a multi-layer cooperative attentional awareness model based on selective attention and sparse perception mechanism was constructed, realizing the real-time perception of traffic elements and understanding of the driving environment in unmanned vehicles in a wide range of traffic scenarios.

2. A three-layer positioning method integrating vehicle state, GPS, maps, and real-time sensing is proposed to realize a rapid method for constructing lane-level high-precision maps and a bounded

positioning error correction method that combines high-precision maps and visual laser sensing. Significantly improves the local sensing robustness and global positioning accuracy in the event of interference or loss of satellite signals.

3. A multiple decision method compounding overall situation of "human-vehicle-road" was proposed, ingeniously combines knowledge-based reasoning and model-based decision-making schemes to improve the intelligent decision-making level of unmanned vehicles; Curvature estimation multi-point preview trajectory following method, linear following error is controlled within 20 cm, which is similar to manual driving level.

4. The driverless integration was implemented on different platforms and applied to many companies. Based on the integration of Intelligent Pioneering driverless vehicle platforms and the integration of the "Kuafu 1" driverless vehicle platform, it has conducted research in cooperation with a number of automakers and developed a series successful self-driving cars, such as the Chuanqi GA5 of GAC, the IEV6S electric self-driving car of JAC, the 4x4 unmanned tactical vehicle of Inner Mongolia First Machinery Group, and other unmanned vehicle platforms. Driverless technologies such as SLAM, laser guidance and motion control were applied to multiple robotic platforms of the Anke Smart Cities Technology (PRC) Co., Ltd. The application includes security patrol robots, security service robots, rescue robots and so on.

Based on the studies of this project, many aspects of promotion and application were achieved, from the implementation of a single target task to the implementation of a full range of comprehensive tasks, from a short-distance driving to a long-distance autonomous driving that can adapt to a variety of environments. The project has published 53 academic papers, applied for and authorized 32 invention patents, and obtained 7 software copyrights.

Securing online transaction payment services with achievements on trusted software research

With the popularization of online transaction payment in daily life, payment fraud is explosively increasing. The traditional defense technology with identity authentication has been incapable of handling the incessant emerging payment frauds, which seriously affected the orderly development of network transaction payments.

Supported by the National Natural Science Foundation of China, Professor Jiang Changjun's research team at Tongji University has been conducting in-depth and systematic research on payment security for online transactions. They innovatively proposed a behavioral authentication mechanism for transaction payment risk prevention and control. They built the "behavioral texture" to characterize the unique behavioral habits of every online user. The transaction behavior authentication technology based on analytical model was presented to instantly and accurately identify transaction fraud. The team also established the transaction payment platform based on the virtual cloud technology. They invented the cluster structure of cross-domain resource

Figure1. Trusted network transaction software system.

classification organization and management. An adaptive load balancing method suitable for multiprocessors "cutting peaks and filling valleys" was proposed to effectively improve the system robustness.

The research team and Alipay jointly developed China's largest third-party payment risk prevention and control system, providing secure protection for more than 400 million Alipay real-name users. The capital loss rate decreased from 0.035‰ in 2012 to 0.0097‰ in 2015. Compared with the 3.08 ‰ capital loss rate for the payment platform PayPal in the United States over the same period, it is decreased by more than 300 times which contributes greatly to the reduction of Alipay's huge losses. In addition, they also provide technical support to the China (Shanghai) Free Trade Pilot Zone, the National E-Commerce Integrated Innovation Practice Zone, and the Industrial and Commercial Bank of China.

The research team obtained a number of authorized patents from the United States, Australia, and China and developed eight industry standards. They won the first prize of Shanghai Science and Technology Progress Award in 2015 and the second prize of National Science and Technology Progress Award in 2016. One of the research papers from the team won the Best Paper Award in the 2014 International Symposium on Mobile Ad Hoc Networking and Computing (ACM MobiHoc, one of the conferences of ACM SIGMOBILE). It was the only one and also the first time that the Chinese scholars won this award since the conference was launched 17 years ago.

Scholars in China made landmark achievement in the theory of accounting information and corporate valuation

The market valuation of a firm depends on the expected future cash flows and the risk-based discount rate, where the forecasts of cash flows are derived from accounting information. Since the path-breaking paper by Ball and Brown (1968) examining the relation between accounting earnings and stock returns, the decision-usefulness of accounting information has been the central issue of accounting research. Ohlson (1995) initially constructs the accounting-based-valuation model, in which equity value can be represented as a linear function of book value and residual income. Ohlson' theory shows that the market value of the firm can be expressed in terms of income statement and balance sheet variables, providing theoretical support for the decision-usefulness of accounting information. Based on the linear valuation theory of Ohlson, Zhang (2000) develops a real-option-based model by incorporating growth and adaptation options into a non-linear framework.

Supported by NSFC General Program, by releasing the assumption of the real-option-based valuation theory, Professor Jin Qinglu and his collaborators make innovative contribution by incorporating the institutional factors that affect the frictions and costs of exercising real options into the valuation model.

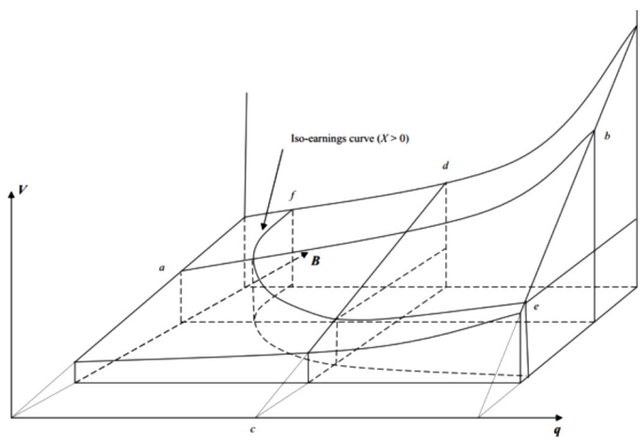


Figure1. Equity value (*V*) is a nonmonotonic function of book value (*B*), given earnings (*X*). Curve *ef* is an iso-earnings curve. As we move along curve *ef*, starting from point e, *V* first decreases with *B* in the high-profitability (low-book-value) region and then increases with *B* in the low-profitability (high-book-value) region.

Hao, Jin and Zhang (2011) further develops the real-option-based valuation theory by taking into consideration of accounting-based growth opportunity. Demonstrating the investment-guiding role of accounting information, their model constructively and comprehensively depicts the importance of accounting

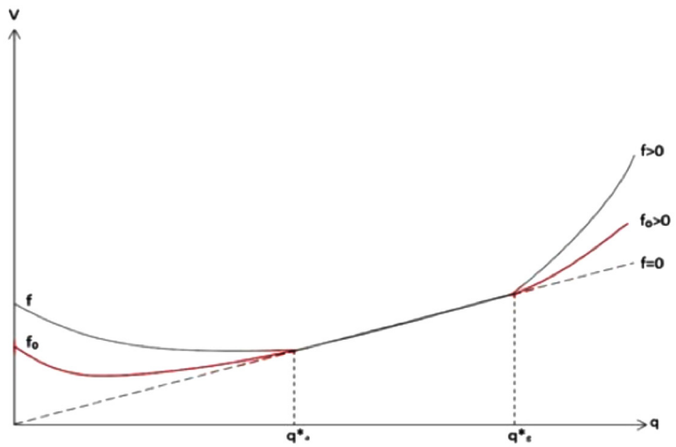


Figure 2. The effect of economic freedom on the convexity of the equity value as a function of profitability *q*. The dotted linear line represents the value of a firm operating in a country without economic freedom (*f* = 0) and maintaining its current operations forever. Growth options are relevant for equity value for $q > q^*_g$. If the firm operates in a country with economic freedom *f* > 0, then equity value (*V*) is an increasing and convex function of earnings (*X*), given equity book value (*B*). Adaptation options are relevant for equity value for $q < q^*_a$. Given earnings, as q moves from q^*_a to its left, equity value has a more convex relation with book value with greater economic freedom *f* than with f_0.

information in value creation.

However, those real-option-based valuation models do not allow for frictions and costs affecting firms' ability to exercise growth/adaptation options. Unlike financial options, the institutional frictions and costs of exercising real options are non-trivial and may have considerable impacts on equity value, which restrict the interpretation and application of valuation models.

In 2015, Jin Qinglu and his collaborators innovatively incorporate the institutional frictions into the real-option-based valuation model. As a milestone in the theory of corporate valuation, their work makes great development and enrichment to the real-option-based valuation models. Employing the real-options-based valuation approach, they find that less institutional frictions or greater economic freedom can give a full play of the market mechanisms (e.g., competition), which can motivate the managers to flexibly adjust the firm's capital investment in response to growth and adaptation opportunities, which in turn increase the convex relation between equity value and accounting variables. Their findings provide theoretical foundation and empirical support for the role of accounting fundamentals in the real-option-based valuation model.

Published on *The Accounting Review*, this paper indicates the remarkable achievement and world-class influence in accounting and valuation research by scholars in China. Their constructive work lays the foundation for further development of corporate valuation theory, and enriches the delegation theory in managerial economics. Their study also has enlightening implication for the valuation role of accounting information, and for the institutional reform of "streamlining governments and delegating authorities" in China.

Studies on the effect of consumer behavior in dynamic pricing make progress

As one of the most important research questions in operations management, pricing has been receiving a great amount of attentions for decades. In the early stage, it is hard to pass price signals throughout the supply chains, price was usually a one-time decision at the beginning of a planning horizon.

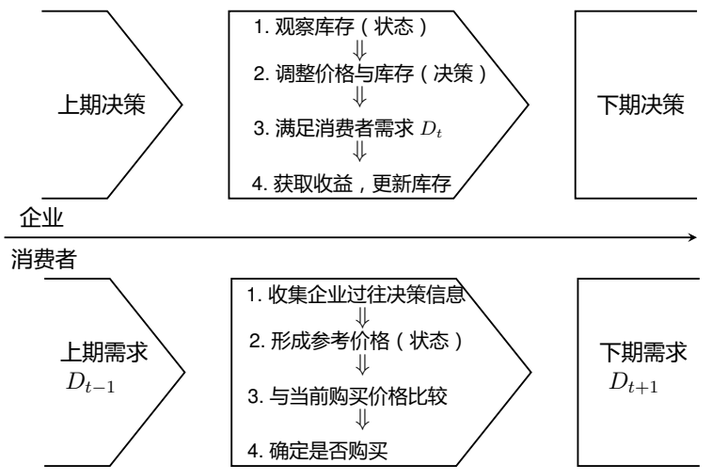


Figure 1. Dynamic decision making and consumer behavior interaction.

Thanks to the rapid development of information technology, by the end of 20th century, dynamic pricing became one of the most vital means to match demand with supply in practice and research focuses in academic research. However, most of the research assumes in a traditional way that consumers passively accept the list price and the demand is only affected by the price at the time of purchase.

With the emergence of business modes and information media such as e-commerce, social networks in recent years, the individual behaviors of consumers have been valued increasingly by retailers. Retailers become more aware of consumer behaviors and observe that in the long-run interactive and repeated purchase scenario, consumers' purchasing decisions are affected by the pricing policy over the whole planning horizon instead of the price at the moment of purchase. On the other hand, retailers' decisions become so transparent to consumers that "smart" consumers are able to adjust their purchasing decision accordingly, which leads to more complicated relationship between demand and price.

As a typical consumer behavior model, the reference price effect indicates that consumers form an anchor on basis of historical prices and then compare with the price to determine whether the latter is worthy. By the prospect theory provided by the Nobel Prize winner Professor D. Kahneman, the effect of relative gain or loss is asymmetric on

customers' purchasing decision. Such effect has been widely recognized in economics, marketing and other areas together with support from a number of of empirical studies. However, research in operations management is still limited because of the lack of methods dealing with the aforementioned asymmetry in dynamic systems.

In recent years, Professor Hu Peng from Huazhong University of Science and Technology has been studying the dynamic pricing problem with reference price effects with the support of NSFC. Hu created some novel analytical tools for dynamic systems in 2013, which then were used to solve the joint dynamic pricing and stochastic inventory problem. He also studied the characteristics of the optimal pricing policy based on different consumer types and designed polynomial-time algorithms to determine the optimal price sequences. The series of research can help enterprises better understand the interaction between consumers behavior and dynamic decision making; moreover, the analytical tools created by Hu and his coauthors are so powerful that they attract a lot of attentions from the academia.

Fusobacterium nucleatum promote autophagy-mediated chemoresistance in patients with colorectal cancer

Gut microbiota are linked to chronic inflammation and carcinogenesis. Chemotherapy failure is the major cause of recurrence and poor prognosis in colorectal cancer patients.

With the support of NSFC, a collaborative study by the research groups led by Professor Fang Jingyuan from Division of Gastroenterology and Hepatology, RenJi Hospital, School of Medicine, Shanghai Jiao Tong University and Professor Zou Weiping from Department of Surgery, School of Medicine, University of Michigan, demonstrated the gut microbiota may modulate chemotherapeutic efficacy, and Fusobacterium (F.) nucleatum abundance has been linked to a shorter survival in patients with colorectal cancer.

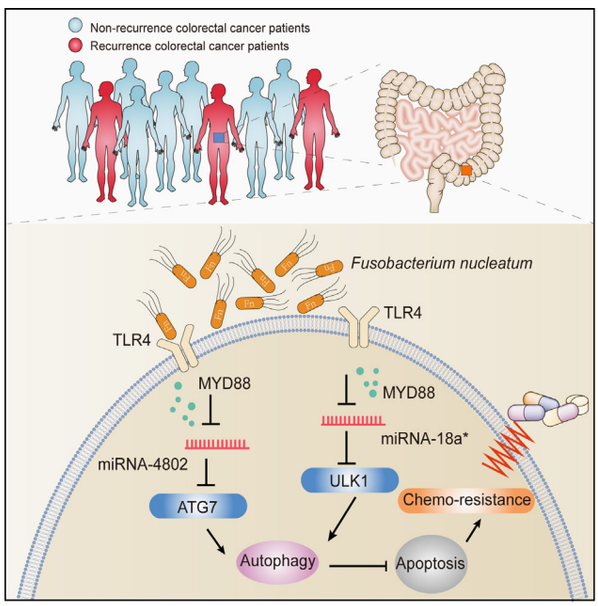


Figure 1. Molecular mechanism of tumor-resistant chemotherapy tolerance by fusobacterium nucleatum.

Fang's group investigated the effects of F. nucleatum on chemotherapy. F. nucleatum was present at higher levels in tissue from patients with recurrent colorectal cancer compared with non-recurrent colorectal cancer and adjacent normal tissue. Furthermore, the amount of F. nucleatum was an independent predictor of colorectal cancer aggressiveness and could predict recurrence. RNA-sequencing of colon cancer cells cocultured with F. nucleatum showed an enrichment of genes involved in autophagy, and coculturing colorectal cancer cells with F. nucleatum induced autophagy, which was associated with chemoresistance. Mechanistically, F. nucleatum targeted TLR4 and MYD88 innate immune signaling and specific microRNAs to activate the autophagy pathway and alter colorectal cancer chemotherapeutic response. Thus, F. nucleatum orchestrates a molecular network of the Toll-like receptor, microRNAs, and autophagy to clinically, biologically, and mechanistically control colorectal cancer chemoresistance. Measuring and targeting F. nucleatum and its associated pathway will yield valuable insight into clinical management and may ameliorate colorectal cancer patient outcomes.

This study was published on *Cell*, which indicates that F. nucleatum may promote chemoresistance in patients with colorectal cancer, and suggests that anti-F. nucleatum therapies should potentially prevent chemoresistance in patients with colorectal cancer.

New advance made in understanding the origin of SARS coronavirus

Bats are natural reservoirs of a variety of emerging pathogens including SARS coronavirus (SARS-CoV). The active surveillance in bats for discovery and characterization of important known pathogens and novel pathogens with potential threats to public health has essential significance for prevention and control of emerging infectious diseases. Since 2005, genetically diverse SARS-related coronavirus (SARSr-CoV) have been detected in multiple horseshoe bat species from different regions in China. However, these SARSr-CoVs showed distinction from SARS-CoV in the spike (S) gene or/ and some accessory genes such as ORF3 and ORF8, and none of them is likely to be the direct progenitor of SARS-CoV that caused the pandemic in 2002 and 2003. A knowledge gap remains in our understanding of the origin of SARS-CoV. The question where and how SARS-CoV originated and evolved in bat reservoirs is yet to be answered.

In the Key Program "Discovery of pathogens of animal origin and researches on its pathogenicity to humans" which was launched in January 2013 by National Natural Science Foundation of China, Professor Shi Zhengli from Wuhan Institute of Virology, CAS and colleagues have performed the sub-project "Discovery and characterization of bat-borne human pathogens and researches on their prevalence, genetic evolution and pathogenicity to humans". Shi and his team carried out systematic studies on the ecological distribution, genetic diversity and evolution of important emerging viruses of bat origin in China represented by SARS-CoV, and evaluated the potential of cross-species infection to humans of newly identified SARSr-CoVs and other bat viruses. Through 5-year surveillance and biological characterization of bat SARSr-CoVs, the team has made important new advance in understanding the origin and evolution of SARS-CoV, which can be summarized as follows:

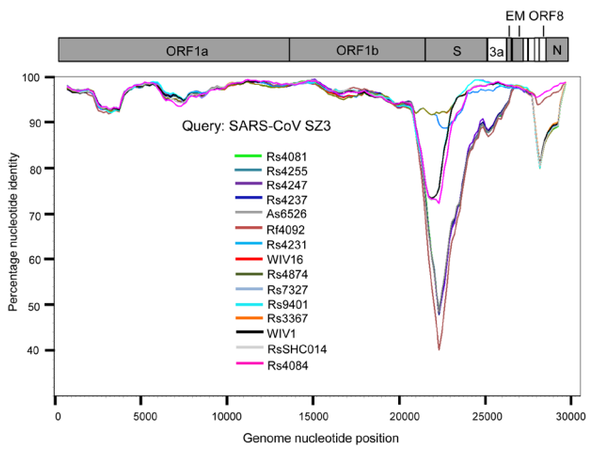


Figure 1. Full-length genome sequence similarity between SARS-CoV and 15 SARSr-CoVs from a single bat cave in Yunnan, China.

1. Discovery of a rich gene

pool of bat SARSr-CoVs in Yunnan Province where a great genetic diversity of SARSr-CoVs have been detected. SARSr-CoVs with high sequence similarity to SARS-CoV in the hypervariable N-terminal domain (NTD) and receptor-binding domain (RBD) of the S1 gene, the ORF3 and ORF8 region, respectively, were all circulating in bats inhabiting a single cave. All building blocks of the pandemic SARS-CoV genome were present in the genomes of different bat SARSr-CoV strains from this gene pool.

2. Proposal of hypothesis about the recombination origin of SARS-CoV. Evidence of frequent recombination events were detected within the S gene and around the ORF8 between SARSr-CoVs from the cave. It is speculated that the direct ancestor of SARS-CoV may have arisen from sequential recombination events between the precursors of these bat SARSr-CoVs.

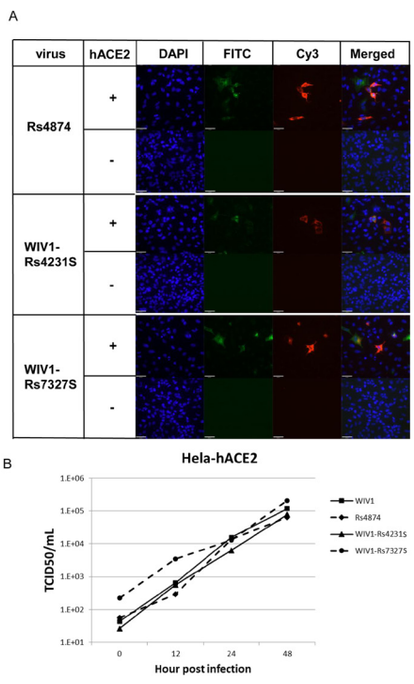


Figure 2. Three newly identified bat SARSr-CoVs with different S proteins are all able to use human ACE2 molecule for cell entry.

3. Identification of different novel SARSr-CoVs with inter-species infection potential. This study has demonstrated that three newly identified bat SARSr-CoVs with different S variants are able to replicate efficiently in Vero E6 cells and are able to use the same receptor as SARS-CoV does for cell entry. It is also the first study to reveal that the accessory genes ORF8 and ORF8a of bat SARSr-CoVs function to activate activating transcription factor 6 (ATF6) and induce apoptosis, respectively, which are similar to those of SARS-CoV.

This study has confirmed the bat origin of SARS-CoV, and provides new insights into the evolution of SARS-CoV. It highlights the risk of future emergence of SARS-like diseases in China and lays important foundation for prevention of bat-borne emerging infectious diseases. The research article entitled "Discovery of a rich gene pool of Bat SARS-related Coronaviruses Provides New Insights into the Origin of SARS Coronavirus" was published on *PLoS Pathogens* on November 2017 and was identified as the Week's Featured Research Article.

Part III

Introduction on Selected NSFC Grants

3.1 Major Research Plan

Physical mechanisms of the formation, evolution and interaction of turbulence structures

The Major Research Plan "Physical Mechanisms of the Formation, Evolution and Interaction of Turbulence Structures" was approved and initiated in 2017. The whole research period of this project is eight years with a total funding of 200 million yuan.

Turbulence is a basic feature of high-Reynolds number flows, and is a ubiquitous phenomenon of flows in natural and industrial processes. Over the past century, substantial progress has been achieved in turbulence research, which has essentially played an important role in promoting the development of related sciences and engineering applications. Yet, turbulence remains a major bottleneck, which severely restricts the rapid development of key technologies associated with national strategic demands. It has been realized that turbulence is characterized by both randomness and orderliness. According to different trigger conditions, the orderliness of turbulence is reflected by various multiscale space-time structures and their complicated interactions (Figure 1), which dominantly control the transport of force, heat and acoustic (Figure 2). It is impossible to take an insight into the physical mechanism of turbulence without considering the turbulence structures. Therefore, a broad consensus is that turbulence structure is the core handgrip for modern fundamental research in turbulent flows. It is widely agreed that taking turbulence structure as the main line

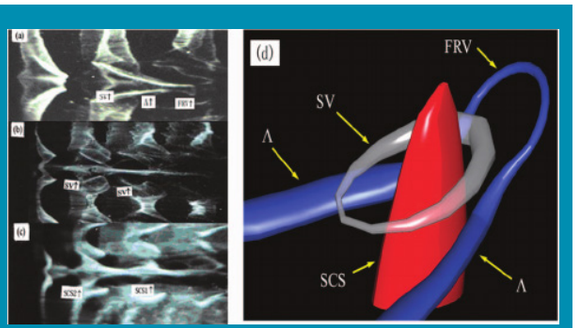


Figure 1. A few typical hydrogen-bubble photos of complex flow structures illuminated by laser sheet at different horizontal heights. The solitonlike coherent structure (SCS), the secondary closed vortex (SV), Λ-vortex (Λ-V) and the first ring vortex (FRV) are shown (left); A three-dimensional structure reconstructed from the photos on the left column, with the corresponding laser sheets locations marked and high-densityhydrogen-bubble traces sketched thereon (right).

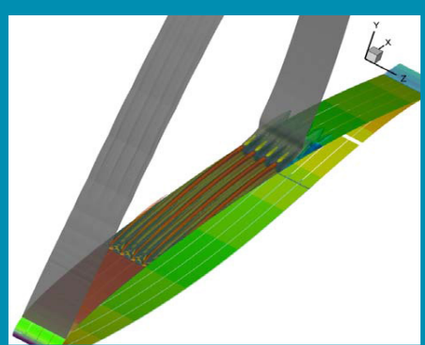


Figure 2. The control of shock waves and flow separation by using vortex generators toward the control of lift and drag forces as well as the stability.

and breakthrough point of turbulence research is crucially important not only for reacquainting turbulence, but for the development of other related disciplines and cross-cutting issues.

Led by Professor Chen Shiyi of South China University of Science and Technology, based on an in-depth analysis of the current status and development trends in turbulence research as well as the significant national demand, the academic steering committee of turbulence experts proposed three key scientific issues from the viewpoints of formation mechanism, evolution characteristics, as well as the prediction and control methods of turbulence structures: (1) The formation dynamics of turbulence structures under various conditions; (2) The spatial-temporal multi-scale dynamics of evolution of turbulence structures; (3) The interaction mechanisms between turbulence structures and transfer of forces, heat and acoustic and control principles.

This Plan is motivated by the significant national strategic demands in the realms of aerospace and navigation as well as the development of various disciplines associated with turbulence. The scientific goal of this Plan is to achieve original innovations in new conception, new theory, new methodology, new technology, etc., including (1) to propose new conception for turbulence research and disruptive original innovative ideas; (2) to propose turbulence theory based on structural element and turbulence model based on spatial-temporal coupling and physical constraints; (3) to give the structure characterization method from a Lagrangian point of view, as well as the spatially and temporally resolved computational and experimental measurement methods with high accuracy and efficiency for three-dimensional near-wall turbulence structures; (4) to propose novel applied design philosophy based on turbulence structure toward flow control, drag reduction, thermal protection, and noise reduction, and improve the accuracy and applicability of applied software for turbulent flows.

In this Major Research Plan, great emphasis is placed on the combination of physical mechanism and applied fundamental researches. Several key and priority research directions have been mapped out, which include high-accuracy numerical method and high-fidelity experimental measurement technology; physical mechanisms of the formation, evolution and interaction of turbulence structures; spatial-temporal evolution characteristics of turbulence structures; spatially and temporally accurate modeling of turbulence; verification and validation of turbulence models; accurate prediction and control of turbulent drag, heat transfer rate, and turbulent noise, etc.

It is anticipated that the implementation of this Major Research Plan will certainly enhance the global status of China in turbulence research and the overall independent innovation capability, and get to the root of several key and fundamental issues of turbulence encountered in nationally significant engineering applications. Meanwhile, it will surely provide necessary scientific and theoretical support for the great-leap-forward development of related technologies.

Dynamic modifications of biomacromolecules and chemical intervention

This Major Research Plan was initiated in 2017 with the proposed duration of 8 years and the total funding of 200 million yuan. The first five years is phase I that focuses on initial project funding, while the remaining time is phase II that focuses on integrated and converged projects. A research pattern of "local" and "full" will be adopted to encourage free exploration, with the incubation of some important directions. In phase II, the guiding role of top experts will be fully explored and more integrated projects will be continuously supported.

Figure 1. Overview of Major Research Plan "Dynamic modifications of biomacromolecules and chemical intervention".

Biological macromolecules (proteins, nucleic acids and glycolipids, etc.), the basic "components" for executing physiological activities as well as the basic materials for life processes, are under dynamic chemical modifications and regulations. These dynamic chemical modifications play key roles in regulating both individual developments and cellular phenotypes, and play a decisive role in the occurrence and development of diseases. The dynamic modifications of biological macromolecules have presently become one of the most appealing frontiers in life sciences, and the most active research frontier lay at the interface between chemistry, life sciences and medicine. The basic questions in the dynamic modifications of biomacromolecules are to discover and elucidate the dynamic properties of physiologically important chemical modifications on biological macromolecules, to reveal their regulatory mechanisms and biological effects, as well as to realize the targeted chemical intervention.

This project aims to take the research paradigm of chemical biology as a guide. Through the interdisciplinary approaches including chemistry, life sciences and medicine, the research aims to develop specific labeling and detection toolkits for the dynamic modifications of biological macromolecules, to analyze their regulation mechanisms and functional relationships, to provide potential intervention molecules and new drug targets, as well as to improve our knowledge and regulation approaches of physiological processes.

The program organizes scientists with different backgrounds including chemistry, life sciences, medicine, mathematical sciences, information sciences and other disciplines to conduct research together. It aims to solve the

following core scientific questions: (1) The dynamic properties of chemical modifications of biological macromolecules: the chemical characteristics and dynamic processes; (2) The regulatory mechanisms of dynamic modifications of biological macromolecules: the biological effects and regulatory mechanisms of dynamic modifications; (3) The chemical interventions for dynamic modifications of biological macromolecules: new targets and targeted intervention strategies based on dynamic modifications.

This research plan, aiming at major national needs, carries out chemical biology studies on the dynamic modifications of biological macromolecules in a targeted manner. The research will be focused on the following three aspects: (1) Chemical labeling and detection technologies for the dynamic modifications of biological macromolecules; (2) Functional studies of regulation mechanisms of the dynamic modifications of biological macromolecules; (3) Chemical interventions and their applications on dynamic modifications of biological macromolecules.

Through solving the above scientific problems, it expects to achieve the following goals: To lead the researches of dynamic modifications of biological macromolecules and chemical interventions, providing new chemical tools and modes for the study of the mechanism of dynamic modifications and acquiring new drug targets and intervention molecules; to speed up the translational researches from basic sciences to drug developments, providing a basic and forward-looking science and technology reserves for the understanding of life processes and the diagnosis and prevention of major diseases; to create an interdisciplinary research team, improving the comprehensive strengths of basic research on the dynamic modifications of biological macromolecules and applied researches on drug developments, occupying an important position in the fields of international chemical biology and biomedical researches.

Organelle interactome for cellular homeostasis

The overall funding for this Major Research Plan is 200 million yuan over the time frame of eight years (2017-2024), with the first five years (2017-2021) to launch projects and take applications, and the latter phase (2021-2024) to integrate the research programs.

Organelles are the subcellular structures in eukaryotic cells with specific morphology and functions to execute specialized cellular processes. Each type of organelles carries out their unique functions, yet different organelles also interact with each other and coordinate to accomplish new physiological functions. Deregulation of organelle interactions, or the organelle interactome, is intimately associated with the development of numerous diseases. Classic molecular and biochemical research started with focusing on single gene or single protein, and flourished with the study of gene networks and protein interactomes, such that the comprehensive and systemic understanding of life became possible.

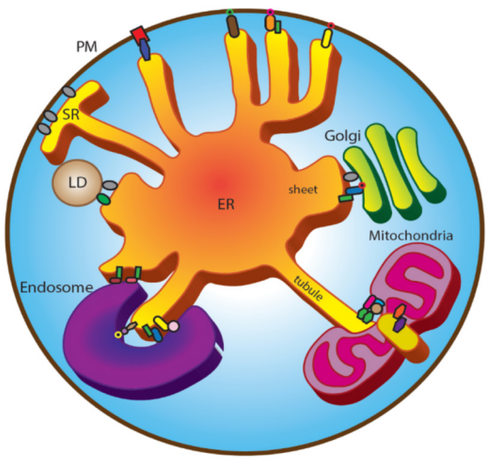


Figure 1. Organelles of a eukaryotic cell.

Nevertheless, the highly compartmentalized nature within the eukaryotic cell, in the form of membrane-enclosed organelles, enables various biological reactions to take place in an efficient yet ordered manner. Therefore, different organelles exhibit functional specialization as well as tight coordination. The close contacts and crosstalk between different organelles mediate the rapid exchange of substances and information and execute numerous biological processes in the cellular life.

This Plan is led by Professor Chen Xiaoguang, CAS member, from Tsinghua University. It expects to break through the limitations of research on a single type of organelle to achieve the systematic understanding of the regulatory mechanisms underlying complex biological processes. The central scientific questions are how organelle interactions regulate the basic cellular processes such as transport, recycling and reuse of biomolecules, organelle biogenesis and homeostasis, etc.; what are the molecular basis and regulatory mechanisms of organelle interactions; what are the principles and functions for the establishment of the organelle interactome.

Major funding areas:

1. The discovery, characterization and network mapping of organelle interactions: characterization of specific organelle interactions; analysis of the parameters of organelle interactions including morphology, kinetics, directionality and force; accurate quantification and description of the dynamic changes of organelle interactions.

2. The mechanisms of the establishment

and maintenance of the organelle interaction network: discovery of the mechanisms underlying the homeostatic regulation of organelles; characterization of novel proteins and lipids involved in organelle interactions; exploration of the structure and function of proteins involved in organelle interactions; mapping of the molecular network of organelle interactions; understanding of the mechanisms responsible for establishing and maintaining the organelle interactome.

3. The mechanisms regulating organelle interaction dynamics: investigation of the dynamic characteristics of organelle interactions; elucidation of the regulatory mechanisms by which organelle interactions contribute to membrane rearrangements under physiological or stressed conditions; discovery of the mechanisms regulating the dynamics of organelle interactions.

4. The physiological and pathological functions of organelle interactions: discovery of novel types of interactions between organelles; dissection of the physiological functions of organelle interactions at the cellular, tissue, or organism level; exploration of the function of organelle interactions in organism development, tissue homeostasis and stress adaptation; elucidation of the pathological implications of dysfunctional organelle interactions in the development of diseases.

Tethyan geodynamics

The purpose of the Major Research Plan "Tethyan geodynamics" is to unravel the fundamental problem that hampered the development of solid earth sciences. The Plan will take full advantage of the regional superiority of the Tethyan realm and conduct multi-disciplinary comprehensive study, which helps to improve the progress of current earth science and the major national needs. The budget for this Plan is 200 million yuan and the estimated implementation period is 8 years.

Led by Professor Wu Fuyuan, this Plan tries to solve the core scientific issue of the dynamics of single-directed amalgamation of multi-continental blocks, which can be subdivided into the following three key questions:

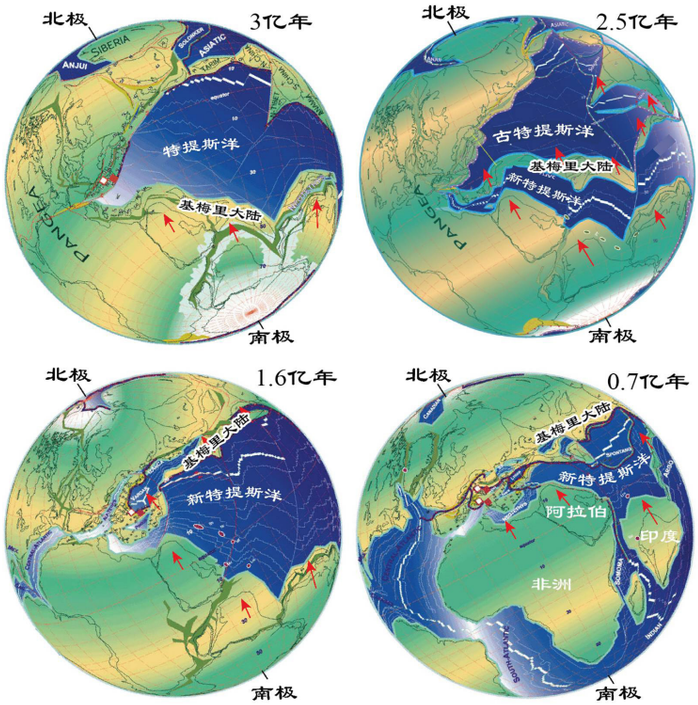


Figure1. The sketch map of Tethyan evolution.

1. Discrimination of the initiation of plate boundaries

The biggest obstacle to understand how plate tectonics operate is the inability to outline the initial indicator of the different types of plate boundaries. It is necessary to better know the indicators of the rifted ocean basin and subduction zone, which will help to effectively restore the evolution history of each continental block, and then put constraints on its dynamic process.

2. Process of continent single-directed break-up and assembling

The continental single-directed break-up and assembling in the Tethyan realm is still in the descriptive stage. It is not clear about the nature of each block, where they drifted away, and when and how they collided onto the previously converging continent. It is necessary to constrain the history and process of break-up and assembling of multi-continental blocks, which will help to know the mechanism of single-directed amalgamation.

3. Nature resource in the process of single-directed rift and amalgamation of multi-continental blocks

There has been no systematic understanding of the processes, mechanisms of the interaction between the various layers of the Earth. It is urgent to reorganize the above issues from the perspective

of earth system science. It is necessary to clarify how the structure and composition of lithosphere changes during the single-directed amalgamation of multi-continental blocks, and how those processes couple with the accumulation and/or preservation of giant nature resource.

The overall scientific goals of this major research plan are: to highly integrate the observations, exploration, analysis, modeling and experimental methods of earth sciences, mathematical sciences and information sciences, to study the interaction between the oceanic and continental lithosphere in the Tethyan realm, to elucidate the dynamic process of tectonic evolution of Tethyan realm, to unravel the driving force of plate tectonics. It analyzes the distribution and formation rules of key nature sources in the region, and provides scientific support for China's resource and energy strategy. Through extensive substantial scientific and technological cooperation, we establish collaborating relationships with other countries within the area covered by the Belt and Road initiative, as well as provide scientific support for the national Belt and Road initiative.

3.2 Basic Research Center Program

Luminescence from molecular aggregates

This project is led by Professor Tang Benzhongfrom South China University of Technology (SCUT), with 9 co-principle investigators from SCUT, East China University of Science and Technology, Tsinghua University and Zhejiang University. The funding of this project is about 200 million yuan for the first 5 years.

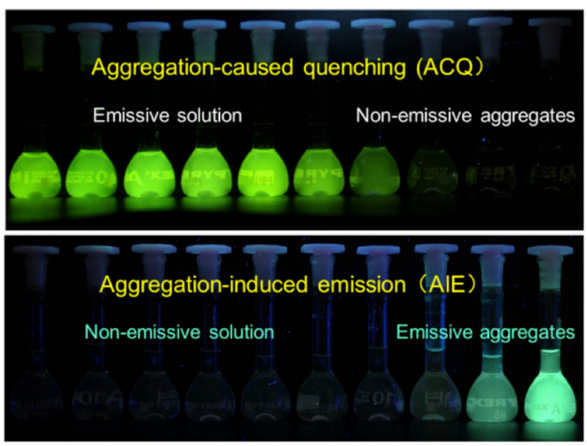


Figure 1. The emission behaviors of ACQ and AIE under irradiation by a UV lamp (365 nm).

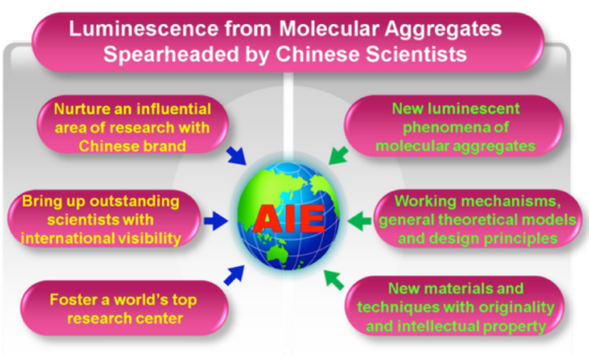


Figure 2. Project outline of luminescence from molecular aggregates.

The "aggregation-induced emission (AIE)", a novel photo-physical concept that refers to a unique phenomenon that the non-emissive luminogens are induced to emit intensely upon aggregation (Figure 1), is of great significance in both academic researches and practical implications because it not only overturns the general belief of aggregation-caused quenching (ACQ), but also arouses a profound revolution in the fields of molecular design, working mechanism and practical applications of luminescent materials. So far, numerous new functional materials and techniques with originality and intellectual property have been developed based on AIE, which has greatly changed the current situation that key materials, techniques and patents are mostly controlled by foreign research institutions or companies. Now, AIE has developed into a new research front that is spearheaded by Chinese scientists and followed by researchers at more than 1100 institutes from more than 60 countries and regions.

AIE research was ranked No. 2 as a key hot research front in 2015 as reported by the National Science Library, Chinese Academy of Sciences and Thomson Reuters. AIE materials were hailed by a *Nature* News Feature articles as one of the four key materials for the coming "nanolight revolution".

To further study the luminescence of molecular aggregates, this project has organized a

strong research team composed of scientists with excellent track records in the area of AIE study. Through synergistic collaboration effort, the project will work towards discovering new luminescent phenomena of molecular aggregates, elucidating working mechanisms for the new light-emitting processes, establishing general theoretical models and design principles, and developing efficient, economic and environmentally benign AIE materials and technologies, in an effort to tackle the significant scientific issues and current challenges in the areas of energy, environment and health (Figure 3). The key funding directions of the project include: (1) the basic scientific principles of luminescence from molecular aggregates, such as AIE mechanism depiction, quantitative prediction and theoretical modeling, luminescence from non-aromatic materials, organic room temperature phosphorescence, radiation relaxation of high-energy excited state, through-space conjugation effect, and so on; (2) the development and application of novel functional materials and techniques based on luminescence from molecular aggregates, such as high-efficiency, energy-saving and low-cost photoelectric conversion materials and devices; (3) selective and sensitive techniques and devices for environmental monitoring and defense security; (4) specific and long-term biological fluorescent probes and reagents, new luminescent materials and techniques for biomedical, bio-imaging, diagnosis and treatment, and so on.

The project aims to nurture a more influential area of research with Chinese brand, bring up a group of outstanding scientists with international visibility, foster a world's top research center, and contribute to the science and technology development and societal advancement in China.

Designing future crops

The NSFC Basic Science Research Center Project entitled "Designing Future Crops" is led by Professor Han Bin (CAS member) from the Center of Excellence for Molecular Plant Sciences/ Shanghai Institute of Plant Physiology and Ecology, CAS. The funding of this project is 180 million yuan for 5 years. Other nine principal investigators in the project are leading plant scientists including Professor Li Jiayang (CAS member), Professor Cao Xiaofeng (CAS member), Professor Gao Caixia and Professor Tian Zhixi from Institute of Genetics and Developmental Biology, CAS, Professor Chen Xiaoya (CAS member), Professor Lin Hongxuan (CAS member) and Professor Wang Jiawei from Shanghai Institute of Plant Physiology and Ecology, CAS, Professor Chong Kang (CAS member) from Institute of Botany, CAS and Professor Qi Yijun from Tsinghua University.

Plant research in China has developed in leaps and bounds over the past 20 years, and China has played leading roles in the world in several key fields, including agricultural genomics, crop functional genomics, and plant hormone mechanisms. With the state government consistently increasing its investment in basic research and a large number of talented young scholars either returning to China from overseas or being fostered at home, China has transformed from being a follower to a leader in plant sciences. Its success was demonstrated in a 2017 *Nature Plants* editorial titled A Chinese Renaissance, which commended China's outstanding achievements in agricultural sciences. Under the background of rapid global population growth, climate warming,

Figure1. Overview of NSFC Basic Science Research Center Project "Designing future crops".

continuous reduction of arable land, and soil retrogression, the basic plant research such as dissection of the genetic basis and molecular mechanism underlying plant natural variation, elucidation of the key genes responsible for crop yield, quality, and resistance and establishment of accurate and efficient genome editing technology is of great strategic significance to design future crops in safeguarding world food security.

Using major crops and model plants as research systems, the project intends to investigate

the genetic and epigenetic variation of plant genomes, molecular mechanisms of plant environmental adaptability, the molecular basis for the formation of important agronomic traits, and future crop design. The ultimate aim of the project is to boost rational crop design through integration our knowledge in plant domestication, adaption and plasticity.

Based on the expertise of each team members and introduction of new incentive mechanisms to drive innovation and cooperation, the project also aims to build up an excellent research team continuing doing cutting-edge plant basic research, producing milestone landmark research achievements, and leading international plant research directions.

Towards high efficient materials via reconstructing correlation effects

This project with a total funding of 180 million yuan is led by Professor Nan Cewen CAS member from Tsinghua University and Institute of Chemistry, CAS also took part in the project. Other professors and researchers participating in the project include Professors Xue Qikun, Duan Wenxuan, and Zhou Ji, who are also members of CAS, and Guo Yuguo, Li Jingfeng, Lin Yuanhua, Zhang Zhengjun, Yurong and Wang Yayu. They are young or middle-aged scientists who work at the frontline of material science, condensed matter physics and material chemistry research with great impact on the international community.

Materials science and technology provide the materials basis for economic development and national security. The rapid development of modern high-tech industries depends more closely on the research and development of new materials;and the basic research, developments and applications of new materials reflect the level of science and technology and industrial competitiveness of a country. In recent years, with the rapid development of science and technology in China, high-end materials have become the bottleneck restricting industrial innovation and national security. The developments China information and energy technologies need urgently novel high-efficient, high-performance (electrical-mechanical-magnetic-heat) function-conversion materials. It is of crucial importance to our mid- and long-term development strategy. Novel high-efficient materials are also a frontier in materials science. High efficient, high performance materials involve rich scientific problems to be solved, and the establishment of the theories for high efficient materials will also provide the basis for the developments of related disciplines. In principle, the macroscopic physical properties of materials are determined by the correlations and manipulation of multiple degrees of freedom, i.e., lattice, charge, spin, and orbit, in materials.

The core in the scientific problems of this Basic Science Center Project is how to change and control the normal correlations between these multiple degrees of freedom in materials. Via reconstructing the correlations (i.e., decoupling correlations or strengthening correlations), novel mechanisms and methods will be established to achieve high efficient functional materials, and to realize high efficiency inenergy storage and conversion, as well as information storage and processing.

This project will be based on the three platforms on multiple degrees of freedom and multi-scale correlation calculations, control of multi-scale structures, and precise characterization of fine structures. By focusing on the next generation high efficient energy storage and conversion, high efficient information storage and processing, innovative basic research will be carried out to solve bottlenecks in the developments of energy and information technologies. The major funding directions of this project include: (1) ultra-high-power energy storage dielectric materials and high-energy-density energy storage devices; (2) high efficient

thermoelectric materials and devices; (3) multiferroic materials and new magnetoelectric devices of ultra-low power consumption; (4) topological quantum materials, physical properties and new concept devices.

Based on the new concept of correlation reconstruction, this project intends to integrate in-depth disciplines of materials science, physics, and chemistry, to develop a theoretical framework of high efficient materials, to solve the dilemma of materials properties that are mutual limiting, to find novel high efficient materials, and to obtain a number of original achievements. The project will open new international academic frontiers on high efficient materials, to establish an international center leading the development of advanced functional materials, to form a world-class academic research high ground in advanced materials, and to cultivate a group of influential scientists. At the same time, it is expected to make major breakthroughs in application technologies of high efficient materials, to promote technological change and provide high efficient materials and technical support for social-economical demands.

Innate immunity and inflammatory diseases

This 5-year project with 190 million yuan grant by NSFC is led by Professor Cao Xuetao (CAS member) from Institute of Basic Medical Sciences of Chinese Academy of Medical Sciences and carried out by co-principle investigators from University of Science and Technology of China, National Institute of Biological Sciences, and Xiamen University.

Inflammatory diseases such as cancer, diabetes, cardiovascular diseases, autoimmune diseases are severe disorders with high incidence. Efficient initiation of inflammatory innate immune response is essential to eliminate the invading pathogens and damaged tissues; however, overactivation or inappropriate activation of the inflammatory innate immune response may induce damage of host tissues and consequently lead to the pathogenesis of the inflammatory diseases. So, the initiation and termination of inflammation and innate immunity are finely controlled through the activation and death of innate immune cells after recognizing the invading pathogens or "dangerous" self-components. Different types of cell death lead to release of different intracellular substances, which may initiate the second round of inflammation and innate response with different outcomes. However, how innate immunity participates in the initiation, acceleration, amplification and resolution of inflammation and how cell death regulates pro-inflammatory or anti-inflammatory processes still remain unclear, which have greatly restricted our understanding of pathogenesis of inflammatory diseases and impeded the prevention and treatment of inflammatory diseases. In the last decade, Cao's team, as one of the world's leading research teams, made substantial progress with a series of representative achievements in the field of innate immunity and inflammation, for example, we created a new field called "pyroptosis and inflammation". This project will study the molecular and cellular mechanisms for the activation and death of innate immune cells and their roles in the inflammatory diseases, focusing on the

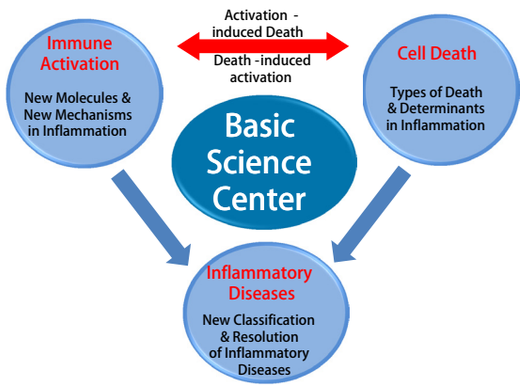


Figure 1. Innate immunity and inflammatory diseases.

Figure 2. Investigators and their collaborative studies.

basic and translational systems model (Innate Receptor←→Cell Death←→Inflammatory Diseases).

The project goes further to investigate the new mechanisms of activation and death of innate immune cells, aiming to propose the previously unknown mechanistic model and keeping our world-leading position in the field. It will also illustrate the role of cell death in the consequent activation or inhibition of immune cell response and its balancing mechanisms, resolving or unresolving, during different phases of inflammation. From a new angle of view (innate immunity and cell death), this project will uncover the fundamental mechanisms of "cascade amplification" and "resolution" of inflammation, aiming to put forward new theories of innate inflammatory responses and develop new immunological therapeutic approaches, and thereby leading the basic research of inflammatory diseases in the world.

3.3 Special Fund for Research on National Major Research Instruments

Detonation driven hypervelocity and high enthalpy shock tunnel

The project "Detonation driven hypervelocity and high enthalpy shock tunnel" by NSFC Special Fund for Research on National Major Research Instruments is led by Professor Jiang Zonglin from Institute of Mechanics, CAS with a total funding of 77.102 million yuan.

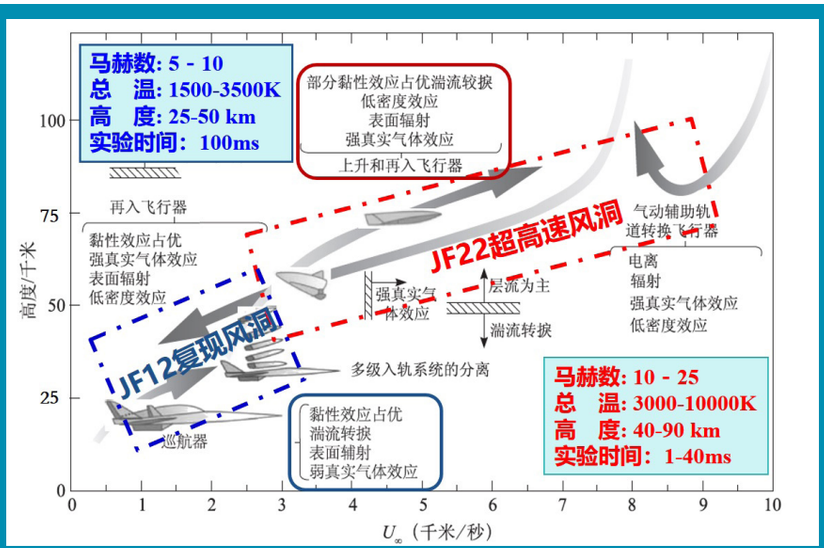


Figure 1. The orientation of the forward detonation driven hypervelocity and high enthalpy shock tunnel.

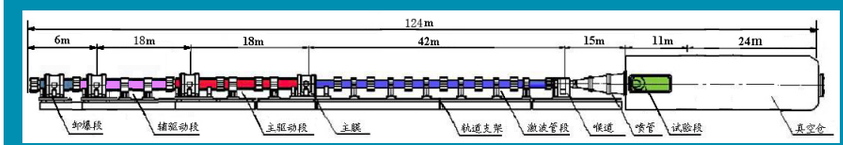


Figure 2. The schematic of the forward detonation driven hypervelocity and high enthalpy shock tunnel.

High-temperature gas dynamics is of fundamental importance for the development of hypersonic vehicles in aerospace. It is the key issue for hypersonic ground test facility to reproduce the real gas effect and high-temperature boundary layer development. Therefore, the development of large-scale hypervelocity and high enthalpy tunnels, and its measurement technologies has been a frontier topic for decades. Such facilities are of significant importance in revealing the real gas effect and hypersonic boundary layer development mechanisms, evaluating the conventional wind tunnel testing similarity law and scale law related to hypersonic reacting flows, and predicting aerodynamic characteristics of advanced hypersonic vehicles.

The group in State Key Laboratory of High Temperature Gas Dynamic, Institute of Mechanics, CAS, proposed a project to develop a forward detonation-driven hypervelocity and high enthalpy shock tunnel (JF22 hypervelocity wind tunnel), and setup the hypersonic ground testing power that can simulate hypervelocity flows of the velocity 3−10 km/s, the total temperature 3,000−10,000 K, the nozzle exit

diameter of 2.5 m at the flight altitude of 40–90 km. This group has proposed a set of theories and technologies for the wind tunnel, including the forward-detonation cavity driver, the double-ignition timing method, the tailored interface matching condition for forward detonation driven shock tunnel and the new balance for aerodynamic force measurement with discrete suspension. The key technologies for the JF22 hypervelocity wind tunnel have been validated with the required performance parameters. The project will be supported by the Special Fund for Research on National Major Research Instruments of NSFC, and will be officially launched in 2018. The JF22 hypervelocity wind tunnel will be built up and put into use by the end of 2022.

Once the JF22 hypervelocity shock tunnel and JF12 hypersonic-flight-duplicated shock tunnel can be operated together, the national aero-thermal-dynamic test platform will be established and can be applied to hypersonic testing covering the whole hypersonic flight corridor for aerospace vehicles. This will advance the state of art in the large scale hypersonic test facility, promote the development of hypersonic and hypervelocity vehicles, and drive the research of Hypersonic and High Temperature Gas Dynamics to a higher level.

The apparatus for characterizing the optical and electronic properties of single point-defects in wide-bandgap semiconductors

The development of modern society has benefited a lot from the progress of semiconductor science and technology. By introducing alien atoms (doping) into a semiconductor, its conductive characteristics can be well controlled. But whether such doping is effective relies on the ability to recognize and regulate those defects in semiconductors, especially the point defects. In fact, the understanding and regulation of point defects in semiconductors is the basis for developing their advanced functional electronics and optoelectronic devices.

So far, it has become one of the core tasks in developing the new generation of semiconductor optoelectronic materials and devices to make the short wavelength deep ultraviolet light-emitting and laser diodes based on wide bandgap semiconductors. Compared with traditional semiconductors, short wavelength semiconductor light-emitting materials (AlxGa1-xN and MgxZn1-xO) have been limited by the doping-asymmetry problem, i.e., it is difficult to form the p-type conduction of hole transport in materials, leading to the difficulty in achieving the efficient PN junction light emitting.

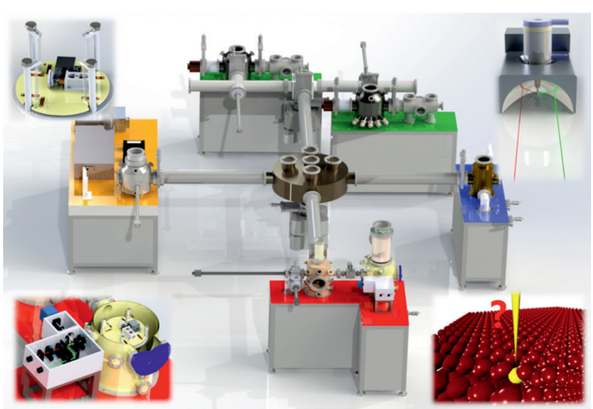


Figure1. Schematic building structure and working principle of the apparatus for characterizing the optical and electronic properties of single point-defects in wide-bandgap semiconductors.

In view of the current research demand for characterizing semiconductor light-emitting materials and devices, this project aims to solve the two core scientific problems of p-doping in wide bandgap semiconductors, i.e., identification of shallow acceptors and suppression of donor compensations.

This apparatus consists of five parts: the core part of the single NSPD characterization system, and the auxiliary parts of the needle processing system, the material growth system, the mm-scale characterization system and the vacuum transmission system. The single NSPD characterization system will be built on the low temperature scanning tunneling microscope (STM) platform, on which to develop the STM integrated spectral analysis system for realizing the four core characterizations of NSPD position, NSPD Raman spectrum, NSPD carrier transient spectrum, and NSPD light emission spectrum. That will accomplish the complete characterization of element composition, bonding structure and energy level position of NSPDs.

The successful development of this apparatus will for the first time bring into reality

the characterization of key physical parameters (element composition, bonding structure and energy level position) of the single bulk defects in wide bandgap semiconductor materials, and establish a set of world-leading characterization instruments with independent intellectual property rights. That will help to solve the current international problem in wide bandgap semiconductors in producing electroluminescent materials and devices, i.e., the high efficient p-type doping problem in ZnO and high Al component AlxGa1-xN. That will lay the characterization technique foundation to overcome such a bottleneck for developing short wavelength semiconductor light-emitting devices, and will further improve the competitiveness of China in the development of new semiconductor optoelectronic devices.

High resolution multi-dimensional radar measurement system oriented to mechanism analysis of aerial animal migration

Radar is the most effective tool for monitoring mass movements of aerial organisms, which has strongly promoted scientific researches of aerial animal migration. Current entomological radars and bird radars are able to roughly observe the group migration of aerial animals, but they have limited capabilities of species identification and trajectory analysis for migratory individuals, which restrict to further understand animal migration mechanism.

Species identification and trajectory analysis of migratory insects are the greatest challenges for radar observation, because insects have the smallest body size and highest migration density among aerial migrants. Therefore, the new generation radar system for animal migration observation should not only measure flight height, spatial density and distribution of insect migrants, but also are expected to achieve individual morphological parameters measurement, such as body length, body mass, wingbeat frequency, head orientation and 3D trajectory, so as to identify insect species and analyze flight trajectory.

For new generation radar system development for animal migration, there are four scientific problems to be solved: (1) The conventional radar technique has poor estimate accuracy for insect body mass and has no capability of insect body length retrieval; (2) The success rate of wingbeat frequency measurement based signal amplitude modulation is not good and moreover the precision has not been evaluated and reported; (3) The 3D head orientation cannot be measured, because the migratory insect is supposed to flight in a horizontal plane in the conventional vertical-looking entomological radar; (4) The 3D trajectory measurement of migratory individuals cannot be realized due to bad spatial and temporal resolution of conventional entomological radar. Thus, the new generation radar system development must have both innovations on radar measurement principle and radar operation configuration.

The project entitled "High Resolution Multi-Dimensional Radar Measurement System Oriented

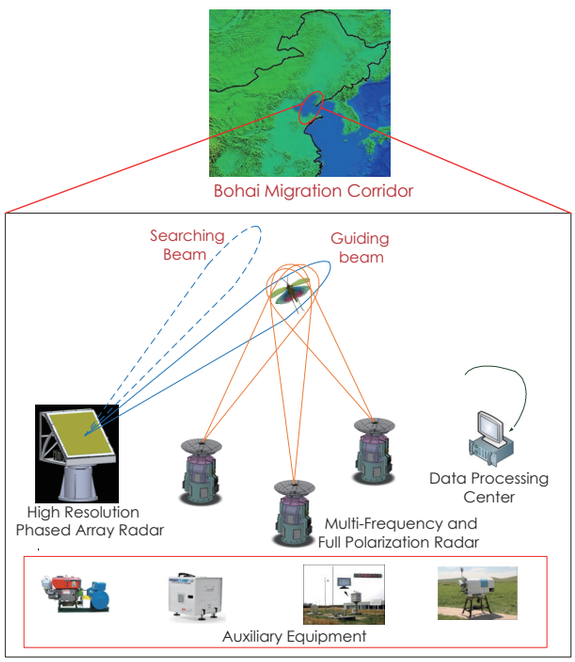


Figure 1. High resolution multi-dimensional radar measurement system oriented to mechanism analysis of aerial animal migration.

to Mechanism analysis of Aerial Animal Migration" is supported by the Special Fund for Research on National Major Research Instruments from NSFC, which aims to research and develop a new generation radar system for animal migration. To address four scientific problems mentioned above, one new measurement principle, two new measurement methods and one new radar operation configuration are proposed and designed, which are insect body mass and body length measurement based on multi-frequency and full-polarization radar cross section (RCS), insect wingbeat frequency measurement based on micro-Doppler effect, 3D head orientation measurement of insect flight based on full-polarization RCS and multi-angle observation, and high-resolution and distributed coordination operation as well.

The high resolution multi-dimensional radar measurement system consists of one high-resolution phased array radar, three multi-frequency and full-polarization radars, and one data processing center, where the high-resolution phased array radar is to measure the group flight parameters of migratory animals, the multi-frequency and full-polarization radars are to achieve morphological-parameters measurement and precise trajectory of insect individual, the data processing center is to achieve species identification and trajectory analysis, and auxiliary equipment are to realize wind and temperature measurement, multi-station synchronization, etc. In radar system development, there are several key techniques. For high-resolution phased array radar, amplitude and phase inconsistency of multi-channels and the effect of wide scanning on radar beam must be calibrated. For multi-frequency and full-polarization radars, the antenna design problem of one aperture with three frequency band and full polarization must also be solved. For data processing center, time-frequency synchronization and multi-station coordination need to be taken into consideration.

The research and development of the high-resolution and multi-dimensional radar measurement system can help reveal the aerial behavioral mechanism of animal migration, clarify aeroecological structure and function, and provide the key supports for the study on the effect of climate change on migratory biomass and trajectories, and the relationship between migratory trajectories and related virus transmission risks. Therefore, it will not only significantly promote the scientific development of aerial animal migration research has the international top-level, but also can provide the effective tool to ensure national security in the areas of agriculture, ecology, epidemic early warning, aviation bird collision, and military defense.

Atom trap instrumentation for radio-krypton and radio-argon dating

Radioactive tracer isotopes, acting as natural time keepers in the environment, have a wide range of applications in the earth and environmental sciences. Once a sample is isolated from the atmosphere, for example, when water is frozen into ice, or when surface water goes underground, the abundance of a radioactive isotope contained in the sample would decrease exponentially due to nuclear decay. As a result, the isotopic abundance can be used to derive the geological age of the sample, and helps understand the dynamic transport process of the sample in the environment.

The radioactive noble-gas isotopes krypton-85, argon-39, and krypton-81 provide a series of precious tracer isotopes for the earth and environmental sciences. Together with carbon-14, they cover a vast effective dating range from a few years to 1.4 million years (Figure 1). However, the natural isotopic abundances of these three krypton and argon isotopes are on the order of 1E-16~1E-11, far below the detection limit of the conventional mass spectrometry methods. This project developed the Atom Trap Trace Analysis method, experimentally demonstrated its feasibility, and showed that this analysis challenge, having lasted for nearly five decades, can in principle be solved. In this method, an atom trap acts as an atom sieve that selects and counts individual atoms of the desired isotope. This project plans to further develop the atom trap method and techniques, and construct a major scientific analysis instrument.

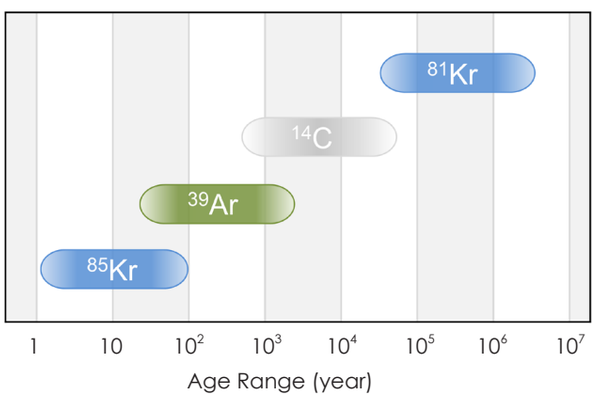


Figure 1. The effective dating ranges of 85Kr, 39Ar, 14C, and 81Kr, each covering approximately 1/6 – 6 times the half-life of the isotope. 14C can already be analyzed using the relatively mature method of Accelerator Mass Spectrometry. The challenge in analyzing 85Kr, 39Ar, and 81Kr is what this project aims to meet.

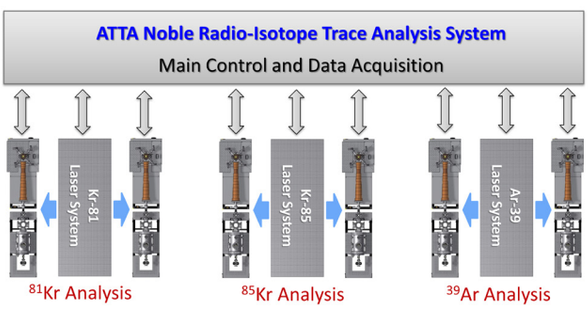


Figure 2. Overview of the atom trap trace analysis instrument. Each atom trap is individually designed and optimized for a particular isotope, each possessing a high atom-loading rate as well as the ability to detect single atoms.

The instrument consists of multiple magneto-optical traps, each designed for a particular krypton or argon isotope, each possessing a high atom-loading rate as well as the ability to detect single atoms. The aim is to significantly decrease both the sample measurement time and the amount of sample needed for each analysis, so that the specs will fully meet the requirements of real-world applications. It plans to investigate every part of the atom trap apparatus, from the atom source at the starting point to the atom detection at the end, and solve a series of technical difficulties through innovation, improvement, and optimization. It will optimize both the optics and the atom optics, and develop high precision laser manipulation techniques. These include high efficiency collimation, focusing, and slowing of the atomic beam, high efficiency cooling and capture of atoms into the trap, and highly sensitive detection of single atoms. Throughout the development, special attention will be paid to the stability and reliability of the instrument.

During the development and testing phase, the researchers collaborate with earth and environmental scientists to date groundwater, ocean water, and glacier ice. A particular example is to study the groundwater circulation and geological environment around Beijing. They will collaborate with the International Atomic Energy Agency to date groundwater in about 12 countries on six continents, and provide scientific data for water resource management. Once complete, the instrument will be used to measure air, water, and ice samples from all over the world, and provide key timing information to the studies of global and regional water and ice circulation processes.

This work will enable both domestic and global collaborations in the earth and environmental sciences, and will help meet certain national needs in environmental monitoring and nuclear safety.

An experimental facility of in-situ/real time monitoring and control in time and space of varying scales for thin film growth defects

Thin film growth represents one of the most important directions of advanced manufacturing. However, manufacturing processes span spatially from meso to macro orders and temporally from femto second to second and there are still many unknown mechanisms for defects and failures. Currently, in-situ and real time measurements are mostly restricted to marco variables, without going to micro processes in both time and space for varying scales. Therefore, there is a lack of effective analysis of mechanisms of defect initiation and evolution and feedback control.

This proposal comes up with an experimental facility of in-situ/real time measurement and control in both time and space for varying scales for thin film growth processes. Research focus will be on fs and plasma enhanced molecular beam epitaxy for thin film growth and integration of fs continuous/burst layer-by-layer imaging, fs electron layer-by-layer diffraction imaging, fs laser assisted-growth and regulation and multi space-time scales modeling and simulation test association system. The research aims to study the ultrafast dynamics behaviors such as formation of

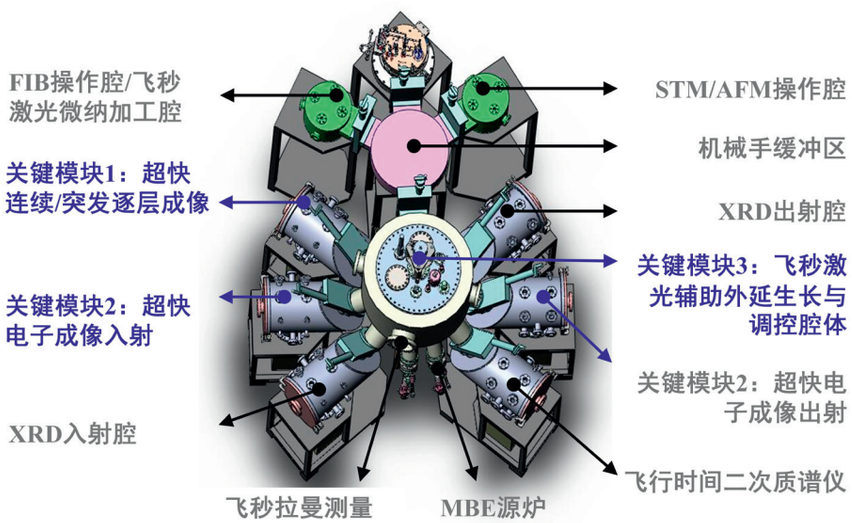


Figure 1. Total effect view of the facility.

the bond and its breakage, re-arrangement of the atoms and molecular, diffusion of electrons and ions, and formation of plasma and evolution, so as to fundamentally understand scientific problem of the energy absorption, transfer, and exchange mechanisms and defect initiation, evolution and control. The experimental facility to be built will not only help China to lead the thin film growth technology in the world and therefore bring the disruptive development of China's high end equipment, but also significantly help advance basic research of physics, chemistry, and biology, etc.

3.4 Creative Research Groups

Galaxies and quasars

The Group on Galaxies and Quasars, led by Professor Luis C. Ho, Director of Kavli Institute for Astronomy and Astrophysics, Peking University, has been funded by the Science Fund for Creative Research Groups in 2017. The main group members are Professors Wu Xuebing, Liu Fu-Kun, and Yu Qingjuan, and Research Professors Jiang Linhua, and Wang Ran.

They will perform a comprehensive investigation of the formation and growth of SMBHs and their connection with galaxy evolution, over the entire cosmic history during the last 13 billion years, trying to make scientific breakthrough in the following aspects: the birth and death of SMBHs, the measurement of the masses of black holes, the luminosity function of high redshift quasars and black holes mass function, the maximum and minimum mass of black holes at low redshift, the bolometric luminosity of SMBHs, Eddington ratio and mass accretion rate, the properties of host galaxies, binary black holes and dual AGN, Tidal Disruption Events (TDEs), Dynamics of galactic center. This is an important frontier project with significant scientific significance in the research on astrophysics today.

Electroweak precise measurements and searching for exotic new physics at TeV hadron collider experiments

The Group on Electroweak Precise Measurements and Searching for Exotic New Physics at Tev Hadron Collider Experiments, led by Professor Han Liang of Modern Physics Department, University of Science and Technology of China (USTC), has been funded by the Science Fund for Creative Research Groups in 2017. The other principle members of the group are Professors Zhao Zhengguo (CAS member), Liu Jianbei, Liu Yanwen and Peng Haiping of the USTC. Closely collaborated with State Key Laboratory of Particle Detection and Electronics, the USTC particle physics group has been long engaged to forge a strong China LHC Physics team, research fields of

which cover TeV hadron collider experiments, novel technology R&D of particle detection, as well as high energy phenomenology.

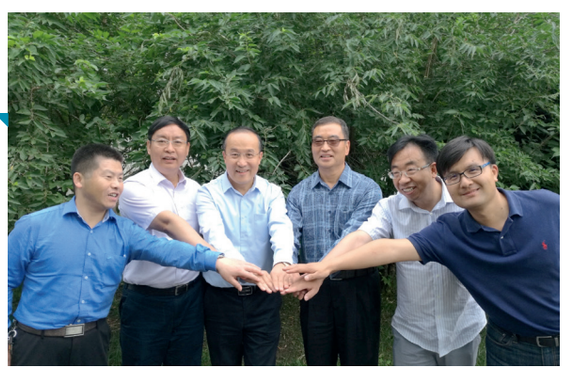
Aiming at the future 10-15 years of long LHC physical run, the USTC group will concentrate on W/Z physics, measurements of rare electroweak processes of multi-vector bosons final states, determinations of Higgs Yukawa couplings with heavy quarks and charged leptons, and further searches for dark matter, extra-dimension, supergravity and exotic resonance signals. It is expected the USTC particle physics team would make recognizable contributions in SM electroweak precise tests to get indirect hints on the potential energy scale of new physics, or direct discoveries of new physics at TeV hadron colliders if existent and applicable.

Functional cluster materials

The Group on Functional Cluster Materials at College of Chemistry and Chemical Engineering of Xiamen University, led by Xie Suyuan and comprised of Zheng Nanfeng, Long Lasheng, Xie Zhaoxiong, Lyu Xin, Tan Yuanzhi, et al., has been funded by the Science Fund for Creative Research Groups in 2017.

The group will continue the researches on the properties of clusters and their hierarchical structures, aim at molecular understanding on properties of functional materials and focus on key scientific issues on structure-property correlations involving in clusters. They are trying to solve the functional modulation depending on clusters, find new model for understanding structure-property correlations and related mechanisms, sequentially, design functional clusters at atomic level, that are expected to largely promote the breakthrough in synthetic chemistry, especially inorganic synthetic chemistry.

Catalytic utilization of biomass



The Group on Catalytic Utilization of Biomass is led by Professor Zhang Tao at Dalian Institute of Chemical Physics, CAS. The team consists of Professors Zhao Zongbao, Yang Weishen, Deng Weiqiao, Zhang Zongchao and Wang Feng.

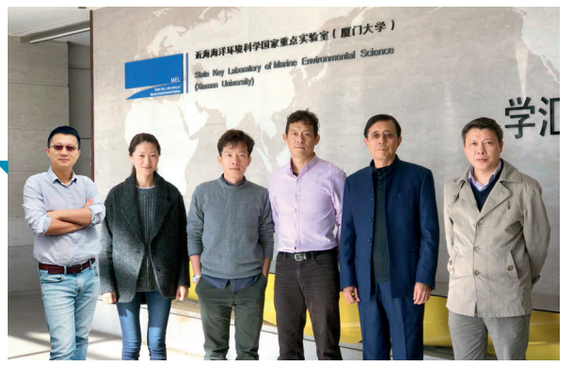
The group will study the catalytic methods of selective activation of C-O/C-C bond of biomass molecule, design and prepare new catalysts for the purpose, and develop new catalytic strategies. The targeted reactions include but are not limited to hydrolysis, dehydration, hydrogenolysis, decarbonylation and hydrogenation reactions. The team will study fundamental issues towards catalytic new processes to produce low-molecular and value-added oxygen-containing chemicals, including alcohols and esters from biomass. For biological conversion of lignocellulosic biomass, efforts will be devoted to pretreatment of raw materials, and fermentation of biomass hydrolysates into ethanol, lipids and related fatty acids derivatives. High performance membranes will be achieved by controllable synthesize and architectural optimization in microscopic and nanoscopic level. Membrane reactors will be further established by coupling of reaction and in-situ separation, which offers significant potential for high efficient conversion of biomass and recovery of diluted products in future. Eventually, integrated routes will be devised to convert biomass into specialt chemicals and high-quality fuel molecules.

Epidemic mechanism and control strategy of important crop Phytophthora disease

The Group on Epidemic Mechanism and Control Strategy of Important Crop Phytophthora Disease is led by Professor Wang Yuanchao from College of Plant Protection in Nanjing Agricultural University and has been funded by the Science Fund for Creative Research Groups in 2017. The group members include Professors Zhang Zhengguang, Dou Daolong, Dong Suomeng and Zheng Xiaobo, as well as 9 junior faculty members and more than 70 graduate students.

With this special fund, the team will focus on three topics: (1) how plants initiate immune responses through the recognition of effector proteins; (2) how the effector proteins interfere with plant immune system; (3) how pathogens regulate the expressions of the effector genes. These studies will provide new fundamental insights into Phytophthora diseases and plant immunity, resulting in development of strategies and technologies to develop novel pesticide, to utilize plant natural resistance, and eventually to establish effective and novel disease control.

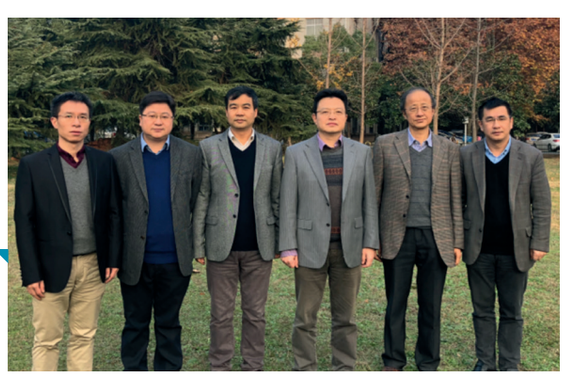
Nitrogen cycle under global change



The Group on Nitrogen Cycle under Global Change has been funded by the Science Fund for Creative Research Groups in 2017. The group was led by Kao Shuh-Ji, funded by the Recruitment Program of Global Experts, at the College of Ocean and Earth Sciences of Xiamen University. The key members of the group include Professors Shi Dalin, Zhang Yao, Chen Min, Gao Kunshan and Liu Zhiyu.

Scientific breakthroughs are expected to be made in the following aspects: (1) by considering different scales from manipulated laboratory experiments to mesoscale ecosystems, then to ocean cruise, it explores nitrogen cycle processes driven by microorganisms enzyme activity and the mechanism of C/N coupling under the scenarios of global change; (2) to establish theoretical and empirical functions of nitrogen, carbon, energy transfer and transfer efficiency at the single cell, population, community and ecosystem levels to reveal the quantitative relationship between marine biological pump functions (ecological and climate regulation) and environmental factors; (3) in-depth understanding of mechanisms of response and feedback of marine ecosystem to climate change to construct a marine ecological model with predictive capability.

Theory and methodology on satellite geodesy and their applications



The Group on the Theory and Methodology on Satellite Geodesy and Their Applications, led by Professor Li Jiancheng, School of Geodesy and Geomatics, Wuhan University, has been funded by the Science Fund for Creative Research Groups in 2017. The key members of the group include Professors Jiang Weiping, Xu Caijun, Yao Yibin, Shen Wenbin, and Zhang Xiaohong.

This group intends to focus on the use of multi-source data from geodesy, and study on the construction of high-precision gravity field modelling, time-frequency methods for gravimetric determination, GNSS navigation and positioning, geodetic and geophysical inversion, ocean dynamic environment, ionospheric anomalies and other issues. It is anticipated to produce a series of innovative research results

in the fields of geodesy and earthquakes, oceans, space environment and hydrology. This group strives for scientific breakthroughs in ultra-high gravity field model construction, global height datum unification, multi-frequency and multi-mode GNSS navigation and positioning optimization and fusion, multi-source geodetic and geophysical joint inversion, multi-scale temporal and spatial variation of ocean dynamic environmental parameters and large-scale ionospheric abnormally driving mechanism, and to promote the interdisciplinary innovation and development of geodesy and related geosciences.

Fabrication, assembly and applications of functional colloidal spheres

The Group on Fabrication, Assembly and Applications of Functional Colloidal Spheres led by Professor Wu Limin, Department of Materials Science and State Key Laboratory of Molecular Engineering of Polymers at Fudan University, has been funded by the Science Fund for Creative Research Groups in 2017. The principal investigators include Professors Jiang Ming (CAS member), Wang Changchun, Chen Daoyong, Yu Yanlei, and Chen Guosong, as well as other 8 researchers. Three of them were funded by the National Science Fund for Distinguished Young Scholars, and two by Chang Jiang Scholars Program.

This group will center on national major application requirements and further investigate and explore new building blocks, driving forces, and assembly methods to realize the controlling structure-property of colloidal spheres. The objective of this research group is to achieve new and much bigger breakthrough in theory and application especially in fabricating hierarchical and functional colloidal spheres and the corresponding assembly films and coatings.

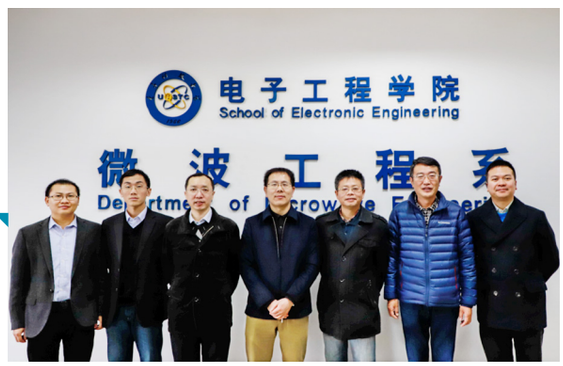
Fundamental researches on key issues of thermo-fluid science in efficient utilization of energy

The Group on Fundamental Researches on Key Issues of Thermo-Fluid Science in Efficient Utilization of Energy, led by Professor He Yaling CAS member at School of Energy and Power Engineering, Xi'an Jiaotong

University, has been funded by the Science Fund for Creative Research Groups in 2017. The main members of the group include Professors Tao Wenquan (member of CAS), Wang Qiuwang, He Maogang, Tang Guihua, and Qu Zhiguo.

The group aims at solving the thermal management problems in extreme conditions, focusing on the following three aspects: the synergy principle of energy conversion and heat transfer in new power cycle system; the thermophysical properties of thermal media under extreme conditions, theory and numerical prediction of complex heat and mass transfer coupled by multi-field; and coordinated control of energy conversion and heat transfer process in new types of power cycles. The group will conduct in-depth studies, strive to make breakthroughs and develop integrated theory for conversion and transportation of thermal energy-mass-electricity in energy system and propose novel efficient utilization methods.

Fundamental theory and key technology of electromagnetic radiation and scattering



The Group on Fundamental Theory and Key Technology of Electromagnetic Radiation and Scattering, with Professor Hu Jun from University of Electronic Science and Technology of China (UESTC) as the academic leader, has been funded by the Science Fund for Creative Research Groups in 2017. The principal group members include Professors Yang Shiwen, Nie Zaiping (IEEE Fellow), Zhao Zhiqin, Sun Sheng, and Qu Shiwei. The group members were supported by the National Science Fund for Distinguished Young Scholars, Excellent Young Scientists Fund, Chang Jiang Scholars Program, the Recruitment Program of Global Experts, and the National Youth Talent Support Program.

This research group plans to continue the studies on computational electromagnetics with more complicated environments and higher efficiency, electromagnetic radiation problems at higher frequencies with wider frequency bandwidth, and electromagnetic detection with higher resolution and more accurate modelling, leading by the national major demands. Its target is to find solutions of major problems in electromagnetic stealth/anti-stealth, safe transmission and detection of electromagnetic information. The group members will put full efforts to make new progress in the following three topics, i.e., electromagnetic scattering modelling of targets in complex environments, novel antenna arrays and stealth design, high-resolution detection and long-distance transmission of electromagnetic information in inhomogeneous media.

Theory and methods for big visual data analysis and understanding

The Group on Theory and Methods for Big Visual Data Analysis and Understanding, led by Liu Chenglin of Institute of Automation, CAS, has been funded by the Science Fund for Creative Research Groups in 2017. The group members include Tan Tieniu, Hu Weiming, Xu Changsheng, Wang Liang and Huang Kaiqi.

Aiming at analyzing and understanding the big visual data in multi-camera surveillance and on the Web, the group will continue to study the evolution law and cognitive computation of big visual data, methods for feature presentation and learning as well as semantic contents understanding, so as to extract from big visual data the semantic information such as scenes, objects, behaviors and events. The technology achieved will largely support the applications for public security, web data filtering, information products development and social management. Specifically, the research tasks include: information theory foundation of compressed sensing of big visual data, cognitive computation models for big visual data, structural representation and learning for big visual data, computing protocol for analyzing big visual data, semantic understanding technology innovation and integration.

Public policy theory and governance institution in China

The Group on Public Policy Theory and Governance Institution in China, led by Professor Su Jun, has been funded by the Science Fund for Creative Research Groups in 2017. Members of the group include Professors Xue Lan, Qi Ye, Zhu Xufeng, Yang Yongheng and Wang Yahua.

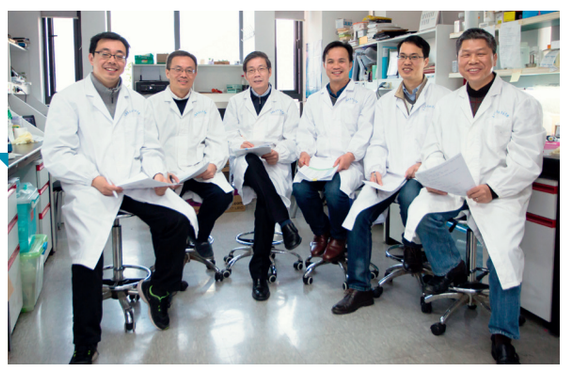
The group will keep deepening theoretical innovation and practical application, in order to achieve great fulfilment in policy network, policy feedback and policy mix, to build up international academic platform, to cultivate a team with disciplinary value and top talents, and to forge an outstanding group with great academic and policy influence at home and abroad.

Financial innovation, resource allocation, and risk management

The group on Financial Innovation, Resource Allocation, and Risk Management is led by Professor Li Zhongfei from Sun Yat-sen Business School, Sun Yat-sen University. Members of the group also include Professors Wang Fan, Fu Ke, Zhu Shushang, Shen Shuguang and Yang Zihui.

In future, the group will focus on issues in financial innovation, resource allocation, and risk management in the specialized areas of pension finance, internet finance, and supply-chain finance. It will endeavor to push the international research frontier by conducting original research in information asymmetry, time inconsistency, complex network structure, behavioral heterogeneity, and big data environment. It also aims to provide influential consulting reports on pressing real-world issues.

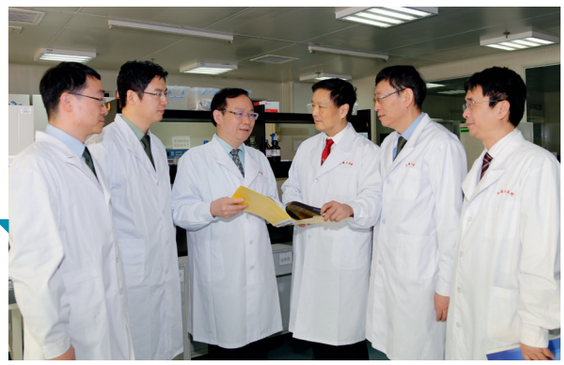
Stresses and cancers



The Group on Stresses and Cancers, led by Professor Chen Guoqiang CAS member and Director of Key Laboratory of Cell Differentiation and Apoptosis of Chinese Ministry of Education, in School of Medicine of Shanghai Jiao Tong University, has been funded by the Science Fund for Creative Research Groups from 2017. The members of the group include Professor Liu Junling, funded by National Science Fund for Distinguished Young Scholars; Professor Zheng JunKe, funded by the Recruitment Program of Global Experts; Professor Zhang Jian, funded by Excellent Young Scientists Fund, as well as Professors Yu Jianxiu and Hong Dengli.

The group will continue to focus on the studies of the underlying mechanisms for the development of liver cancer, colon cancer and leukemia. They will try to address the potential connections between intrinsic changes and cancer microenvironment in cell fate determinations during tumorigenesis. Related research sources and powerful techniques will be reorganized or integrated to break disciplinary boundaries to dramatically promote the progress of studies in cell fate determinations and discovery of novel lead compounds. These studies will benefit the breakthroughs in the delineation of key molecular regulatory networks for cancer cell fate commitments and potential intervention strategies.

The pathogenesis of viral hepatitis and new treatment strategies



Led by Professor Wang Fusheng member of CAS of 302 Military Hospital of China, the Group on the Pathogenesis of Viral Hepatitis and New Treatment Strategy has been funded by the Science Fund for Creative Research Groups in 2017. The key members of this group include Professors Wang Fusheng, Xiao Xiaohe, George K.K Lau, Xu Dongping, Shi Ming, and Zhang Zheng.

The group will focus on chronic hepatitis B and its related key scientific problems of severe liver disease and clinical problems. They will systemically clarify the panorama of overall immune responses during the pathogenesis of chronic hepatitis Band during the antiviral treatment period. Clarifying the key immune mechanism will hopefully lead to a functional cure for chronic hepatitis B. They will also develop new treatment technology, combining traditional Chinese medicine and western medicine, to strengthen specific immune reactions. Meanwhile, they will study the mechanism of immune pathological injury and disease progression of severe liver disease, with the aim of reducing the mortality of chronic hepatitis B-related severe liver disease. The group will strive to achieve a breakthrough with regards to a functional cure for chronic hepatitis B and a reduction in the mortality of chronic hepatitis B-related severe liver disease.

3.5 National Science Fund for Distinguished Young Scholars

Professor Chen Xiaoqian

National University of Defense Technology

Professor Chen is mainly engaged in theory and applications of Multidisciplinary Design Optimization (MDO) of flight vehicles.

Funded by National Science Fund for Distinguished Young Scholars, Professor Chen will continue his research in the field of uncertainty of MDO approach for flight vehicles, with emphasis on three issues concerning Hi-Fi modeling and verification, uncertainty modeling and analysis, and integrated design of reliability, needed to be resolved immediately in engineering field, so as to form a set of effective theories of uncertainty multidisciplinary design optimization of flight vehicles and lay a solid foundation for promoting their overall design level.

Professor Zhou Shuyun

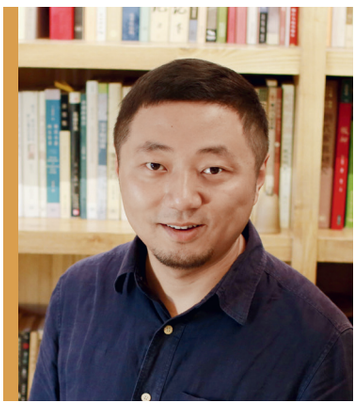
Tsinghua University

Professor Zhou's research field is experimental condensed matter physics. Her research focuses on the electronic structure of novel two-dimensional materials and heterostructures using advanced electron spectroscopic tools, e.g., angle-resolved photoemission spectroscopy (ARPES).

Funded by National Science Fund for Distinguished Young Scholars, Professor Zhou is going to extend her research to the ultrafast dynamics of the non-equilibrium state of two-dimensional materials while continuing her research on the equilibrium state. By capturing the temporal evolution of the electronic structure in the non-equilibrium state with ultrafast (picosecond and even femtosecond) time scales, she hopes to provide new insights on the fundamental physics of these intriguing materials, and to further explore physical properties related to device applications.

Professor Ma Ding

Peking University



Professor Ma's research focuses on the fundamental science about the catalytic C1 resource conversion as well as hydrogen production/storage/transportation processes. He is also working on new catalytic transformation routes for energy-conversion processes.

Funded by National Science Fund for Distinguished Young Scholars, Professor Ma will continue to work on the hydrogen energy as well as C1 chemistry area, addressing the fundamental issues in the activation and reconstruction of C-H, O-H, C-O bonds of those processes. His group will try to develop new catalytic processes, such as producing hydrogen from methane and/or water, and CO2 conversion under mild reaction conditions.

Professor Yang Caiguang

Shanghai Institute of Materia Medica, CAS

The research in Professor Yang's lab mainly focuses on chemical intervention of undruggable proteins, which is a cutting-edge field in chemical biology and impacts on drug discovery significantly.

With the support from the National Science Fund for Distinguished Young Scholars, Professor Yang's research will focus on the chemical intervention of RNA methylation. RNA methylation is a fast-evolving field and represents a new layer of epigenetics, which exhibit broad and important roles in nearly every aspect of the mRNA life cycle, as well as in various cellular, developmental, and disease processes. However, at this moment extremely few small-molecule modulators have been characterized and less is known about the biological phenotype on the selective interventions of RNA epigenetic enzymes, which exists in sharp contrast to factors of DNA or histone epigenetics. Therefore, Yang's lab aims to fill these urgent but unmet needs and devotes to developing high-quality chemical probe for specific regulation on each factor in the functional network for RNA methylation, for example catalytic and reader proteins, protein-protein interactions, and protein-RNA regulations. Such studies might promote the understanding of the basic biology of RNA methylation and hopefully succeed in target validation for drug discovery.

Professor Dai Junbiao

Shenzhen Institutes of Advanced Technology, CAS

Professor Dai's research interests focus on the development of enabling technologies in Synthetic Biology, the design and characterization of standard biological parts, the design and synthesis of eukaryotic chromosomes and their applications, and multi-omic analysis and metabolic modeling. In the past few years, several breakthroughs have been made in these areas in Professor Dai's lab.

With the support from National Science Fund for Distinguished Young Scholars, his lab will continue working on both fundamental researches and industrial applications of synthetic yeast. In addition, his lab will develop novel next-generation DNA synthesis technologies to reduce the cost and to increase the throughput and accuracy of DNA synthesis.

Professor Wang Yanli

Institute of Biophysics, CAS

Professor Wang is interested in the structural biology of Protein and RNA macromolecule complex. Her studies have revealed the molecular mechanism of RNA mediated silencing by the Ago protein, which is a key component of RNA interference pathway. Her systematic studies in CRISPR/Cas Systems demonstrated how bacteria defends the invading nucleic acids by CRISPR/Cas Systems.

With the support from National Science Fund for Distinguished Young Scholars, she will focus on structural studies in CRISPR/Cas Systems and Ago mediated gene silencing. Her studies will provide basic information to optimize the current genome editing tools and develop new tools.

Professor Ding Aijun

Nanjing University

Professor Ding has been mainly engaged in studying the interactions between physical and chemical processes in atmospheric complex pollution, with focus on understanding the feedback mechanisms between air pollution, atmospheric boundary layer and weather processes.

Funded by National Science Fund for Distinguished Young Scholars, Professor Ding will further quantify the interactions of air pollution-atmosphere boundary layer-weather and the related key processes in East Asia. He will optimize the relevant numerical model(s) based on vertical observations of key parameters during typical processes and try to obtain a quantitative understanding of the effects of the interaction of physicochemical processes in the complex pollution of East Asia. These efforts will provide scientific support for the prevention and treatment of atmospheric complex pollution in China.

Professor Fan Junxuan

Nanjing Institute of Geology and Palaeontology, CAS

Professor Fan is mainly engaged in the construction of global geological database and the relevant quantitative analysis.

Funded by National Science Fund for Distinguished Young Scholars, Professor Fan will continue his work on the integrating and sharing of global geological big data, and the application of big data and high-performance computing technology to the studies of the evolution of life during the Earth history and its relationship with environmental fluctuation, global palaeogeographic and palaeoclimatic reconstruction, geological time scale, and the mineral and energy resources exploration.

Professor Chen Xingqiu

Institute of Metal Research, CAS

Professor Chen is a computational materials scientist, concerned with the computer modeling and algorithms of alloy properties and designs using quantum mechanical methodologies with an aim at boosting discovery of new materials and alloying design.

Funded by National Science Fund for Distinguished Young Scholars, he will continue tracking the key problems on the frontier of computational alloying design. Concerning multi-component alloys, the further development will be emphasized on the large scale, multiscale and high-throughput models and algorithms bridging the scales from atomistic to macroscopic levels with the combined considerations of both accuracy and efficiency. The undergoing studies will be emphasized, on one hand, on the design of high-performance alloys on basis of the understanding composition-structure-property relation and, on the other hand, on the exploitation of novel quantum properties of metals and alloys according to anomalous electronic structures, with the main purpose to fast and effectively boost discovery of new materials within the framework of computational materials sciences.

Professor Zhang Jixiong

China University of Mining and Technology (Beijing)

Professor Zhang has been working in the fields of coal mine backfill and strata control for many years.

Currently, the government is advocating the exploration of the deep-level resources. In view of this, Professor Zhang is currently performing leading research in the fields of strata control under high-stress and large-deformation conditions associated with deeper and massive mining operations, with the financial support from National Science Fund for Distinguished Young Scholars. Specifically, his interests focus on strata behavior and its control, interaction between backfill material and surrounding rock mass, and mutual influence of backfill material and underground water, etc., in deep backfill mines. Finally, he aims to propose a new strata control theory based on backfill technology for deep mining.

Professor Zhang Xiuyin

South China University of Technology

Professor Zhang's research mainly focuses on the collaborative design of the antenna, passive and active components in RF sub-systems, and has established some co-design theories and methods of multi-component.

Under the support of National Science Foundation for Distinguished Young Scholars, Professor Zhang will use the digital-and-analog collaboration methods to study the software-defined high-integration digital RF sub-systems based on his researches of collaborative analog RF components. His future researches include the generation, amplification and filtering reconstruction of the RF signals in the transmitter as well as the analog-to-digital conversion and digital RF signal processing technology in the receiver. Based on the key technology study, he is trying his best to put his research outcomes into practice and realize the industrialization. By using the digital RF transceiver as the RF channel, he is trying to build up the multi-band heterogeneous configurable wireless accessing system and the active massive MIMO antenna sub-system for 5G mobile communications.

Professor Wang Jianpu

Nanjing Tech University

Professor Wang's research interests are organic and perovskite based optoelectronics. He pioneered in the research of perovskite light-emitting diodes (LEDs).

With the support of the National Science Fund for Distinguished Young Scholars, Professor Wang will perform further studies on the fundamental scientific topic of the relationship between material compositions, device structures and performance of perovskite LEDs, aiming for realizing high efficiency and long lifetime perovskite LEDs.

Professor Kou Gang

Southwestern University of Finance and Economics

Professor Kou's research concentrates on the big data driven decision-making representation.

Supported by the National Science Fund for Distinguished Young Scholars, Professor Kou's current work focuses on the theory and methods integrating data mining with multi-target decision, to improve the efficiency and smartness of data mining techniques by involving subjective knowledge, and the role of the mined result played in management and decision.

Professor Wu Junjie

Beihang University

Professor Wu has long been working in the area of data mining and big data analytics.

Funded by National Science Fund for Distinguished Young Scholars, Professor Wu will continue his research in exploring big data enabled methods for urban safety management in a spatio-temporal-networked crisscrossing space. He will also pay great attention to some advanced topics including heterogeneous data modeling, interpretable predictions, and data-driven optimizations, which will be very helpful to bridge the gap between big data techniques and management sciences.

Professor Wang Lei

Fudan University

Professor Wang's research focused on reproductive genetics. He is investigating on genetic basis and molecular mechanism of diseases responsible for female infertility.

With the support of National Science Fund for Distinguished Young Scholars, he will continue to focus on genetics of abnormal development of human oocytes and early embryos. The findings will uncover mechanism of human early reproduction, help patients for precision genetic diagnosis and pave the way for the future treatment.

Part IV

Completion and Evaluation of NSFC Projects in 2017

4.1 Overview

In total, 39,062 NSFC projects completed in 2017 (excluding grants of the Tianyuan Fund for Mathematics), including 16,678 of the General Program, 498 of the Key Program, 15,403 of the Young Scientists Fund, 2,449 of the Fund for Less Developed Regions, 400 of the Excellent Young Scientists Fund, 200 of the National Science Fund for Distinguished Young Scholars, 69 of the Science Fund for Creative Research Groups, 63 of the Major Program, 497 of Joint Funds Programs, 370 of Major Research Plan, 3 of the Special Fund for Research on National Major Research Instruments (Departmental Recommendation), 715 of the International (Regional) Cooperation and Exchange Programs, 141 of the Joint Research Fund for Overseas Chinese Scholars and Scholars in Hong Kong and Macao, 71 of the National Fund for Fostering Talents in Basic Research, 359 Special Funded Projects and 1,146 Emergency Management Projects.

Projects completed in 2017 published 406,640 journal articles and 56,420 conference papers, among which 254,665 papers are indexed in SCI. 7,287 people from these projects presented their works in invited talks at international conferences.

Projects completed in 2017 obtained 1,782 patents in foreign countries and 33,457 patents in China. Many projects received national, provincial and ministerial awards. All awardees of the first and second prizes of the State Natural Science Award, the State Technological Invention Award and the State Scientific and Technological Progress Award were previously supported or partially supported by NSFC.

In 2017, with the support of NSFC and other science funding programs, progress in basic research of all disciplines accelerated. Especially in four discipline clusters, development was in full swing. The first cluster includes material sciences, chemistry and engineering. With the world's largest number of publications, China is now holding an equivalent position to advanced countries in science all over the world in terms of research output in the three disciplines. Mathematical and physical disciplines constitute the second cluster, including mathematics, physics, astronomy and information sciences. Striking achievements have been made in crossover of geometry and algebra, quantum information, dark matter, superconductivity, artificial intelligent and neutrino physics. The third cluster is life sciences and presents high speed growth. The fourth cluster is earth/environmental sciences. In recent years, this cluster has been highly valued by the central government and research in the cluster is taking off.

Table 1 Research Outputs of NSFC Projects Completed in 2017

Program		General Program	Key Program	International (Regional) Cooperation and Exchange Programs	Young Scientists Fund	Excellent Young Scientists Fund
Projects Completed		16,678	498	715	15,403	400
Publications	Invited Talks at International Conferences	3,311	964	362	581	387
	Invited Talks at Domestics Conferences	3,278	642	163	659	349
	Journal Articles	209,983	23,323	5,824	96,841	6,136
	Conference Papers	29,884	2,559	1,408	14,724	813
	SCI-indexed Articles	130,593	17,034	4,645	59,381	5,355
	EI-indexed Articles	51,807	5,026	1,721	25,844	1,869
	Monographs	2,930	318	115	1,472	121
Patents	Foreign Patents	788	90	24	466	31
	Chinese Patents	16,582	1,776	466	8,656	481
Awards	National Awards	283	56	21	63	37
	Provincial & Ministerial Awards	1,857	211	55	844	106
Researcher Training	Post-Docs	1,247	289	93	474	86
	Doctoral Students	16,346	2,752	834	3,840	480
	Master Students	43,053	3,530	829	12,083	831

Table 1 Research Outputs of NSFC Projects Completed in 2017 (Continued)

National Science Fund for Distinguished Young Scholars	Science Fund for Creative Research Groups	Fund for Less Developed Regions	Joint Research Fund for Overseas Chinese Scholars and Scholars in Hong Kong and Macao	Major Program	Major Research Plan	Joint Funds Programs
200	69	2,449	141	63	370	497
430	284	76	75	255	253	193
288	156	162	26	135	146	160
6,427	7,153	24,682	1,127	5,778	4,947	8,135
668	707	2,696	265	377	827	957
5,526	5,622	8,381	960	4,575	3,859	4,897
1,994	2,153	3,913	421	664	1,008	2,269
82	65	425	11	41	55	112
71	81	59	1	14	24	79
747	1,102	1,563	40	318	357	928
24	34	12	1	15	12	13
66	71	153	5	40	34	138
103	64	49	17	60	100	67
730	814	555	94	623	710	642
705	853	6,586	121	612	688	1,647

4.2 Statistics of NSFC's Support to Awardees of State Natural Science Award in 2017

In 2017, 2 projects were awarded with the first prize and 33 projects were awarded with the second prize of the State Natural Science Award. Two projects were awarded with the first prize of the State Technological Invention Award. Two projects were awarded with the first prize of with the National Science and Technology Progress Award. All awardees were previously supported or partially supported by the National Natural Science Fund.

Table 2 NSFC's Support to Awardees of the First Prize of the State Natural Science Award in 2017

No.	Project Title	Principal Investigators	Projects Previously Funded by NSFC	Number of NSFC Grants
1	Molecular mechanism for good quality and high yield of rice and design of rice variety	Li Jiayang (Institute of Genetics and Developmental Biology, CAS) Han Bin (Shanghai Institutes for Biological Sciences, CAS) Qian Qian (China National Rice Research Institute) Wang Yonghong (Institute of Genetics and Developmental Biology, CAS) Huang Xuehui (Shanghai Institutes for Biological Sciences, CAS)	Genetic network underlying the coordination of plant height and tiller number in rice	48
2	Aggregation-induced emission	Tang Benzhong (Hong Kong University of Science and Technology) Qin Anjun (Zhejiang University) Dong Yuping (Beijing Institute of Technology) Li Zhen (Hong Kong University of Science and Technology) Sun Jingzhi (Zhejiang University)	Luminescence from molecular aggregates	37

Table 3 NSFC's Support to Awardees of the Second Prize of the State Natural Science Award in 2017

No.	Project Title	Principal Investigators	Projects Previously Funded by NSFC	Number of NSFC Grants
1	Research on several problems in differential geometry	Li Jiayu (Academy of Mathematics and Systems Science, CAS)	Geometric analysis	11
2	Doping mechanism in novel semiconductor materials	Li Jingbo (Institute of Semiconductors, CAS) Gai Yanqin (Institute of Semiconductors, CAS) Kang Jun (Institute of Semiconductors, CAS) Li Shushen (Institute of Semiconductors, CAS) Xia Jianbai (Institute of Semiconductors, CAS)	Quantum regulation in semiconductor low-dimensional structures	28
3	Raman spectrum of low-dimensional carbon materials	Zhang Jin (Peking University) Liu Zhongfan (Peking University) Tong Lianming (Peking University) Peng Hailin (Peking University)	Carbon nanotube-based heterojunction: Controlled fabrication and its applications in photovoltaic devices	37

Table 3 NSFC's Support to Awardees of the Second Prize of the State Natural Science Award in 2017 (Continued)

No.	Project Title	Principal Investigators	Projects Previously Funded by NSFC	Number of NSFC Grants
4	Structure-property relations and reaction regularity of several organic compounds	Liu Lei (University of Science and Technology of China) Fu Yao (University of Science and Technology of China) Guo Qingxiang (University of Science and Technology of China)	Protein chemical synthesis and its application to biochemical studies	24
5	Basics of novel molecular-based ferroelectrics	Xiong Rengen (Southeast University) Ye Qiong (Nanjing University) Fu Dawei (Southeast University) Zhang Wen (Southeast University)	Molecular-based ferroelectrics	23
6	New strategies for stereo- and enantioselective direct transformations of aromatic compounds	You Shuli (Shanghai Institute of Organic Chemistry, CAS) Gu Qing (Shanghai Institute of Organic Chemistry, CAS) Zheng Chao (Shanghai Institute of Organic Chemistry, CAS) Kang Qiang (Shanghai Institute of Organic Chemistry, CAS) Zhuo Chunxiang (Shanghai Institute of Organic Chemistry, CAS)	Development of novel highly selective transformations of aromatic compounds	15
7	Destruction of the North China Craton	Zhu Rixiang (Institute of Geology and Geophysics, CAS) Chen Ling (Institute of Geology and Geophysics, CAS) Zhang Hongfu (Institute of Geology and Geophysics, CAS) Tang Yanjie (Institute of Geology and Geophysics, CAS) Ying Jifeng (Institute of Geology and Geophysics, CAS)	Integrated study on destruction processes and dynamic mechanism of the North China Craton	41
8	Collaborative research of the northeastern margin of the Tibetan plateau: Late Cenozoic tectonic deformation and processes of plateau building	Zhang Peizhen (Institute of Geology, China Earthquake Administration) Zheng Dewen (Institute of Geology, China Earthquake Administration) Zheng Wenjun (Institute of Geology, China Earthquake Administration) Zhang Huiping (Institute of Geology, China Earthquake Administration) Wang Weitao (Institute of Geology, China Earthquake Administration)	Collaborative research of the northeastern margin of the Tibetan plateau: Late Cenozoic tectonic deformation and processes of plateau building	23
9	Genesis of Mesozoic Granites and crustal evolution in Cathaysia Massif	Zhou Xinmin (Nanjing University) Xu Xisheng (Nanjing University) Wang Rucheng (Nanjing University) Shu Liangshu (Nanjing University) Yu Jinhai (Nanjing University)	Evolution of Lithosphere dynamics and genesis of Late Mesozoic Granites in Nanling region, South China	51

Table 3 NSFC's Support to Awardees of the Second Prize of the State Natural Science Award in 2017 (Continued)

No.	Project Title	Principal Investigators	Projects Previously Funded by NSFC	Number of NSFC Grants
10	Pollution characteristics and physical & chemical control of halogenated persistent organic pollutants	Yu Gang (Tsinghua University) Huang Jun (Tsinghua University) Deng Shubo (Tsinghua University) Wang Bin (Tsinghua University) Yang Bo (Tsinghua University)	Biodegradation and AOP stability of potassium oxa-perfluoroalkane sulfonates as emerging contaminants	26
11	Nonlinear runoff generation and transformation	Xia Jun (Wuhan University) Liu Changming (Institute of Geographic Sciences and Natural Resources Research, CAS) Mo Xingguo (Institute of Geographic Sciences and Natural Resources Research, CAS) Wang Gangsheng (Institute of Geographic Sciences and Natural Resources Research, CAS) Zhan Chesheng (Institute of Geographic Sciences and Natural Resources Research, CAS)	Applied basic research on nonlinear runoff generation and its application in middle and small rivers and ungauged basins	32
12	Recognition, transformation and regulation of natural risk substances in potable water	Yang Min (Research Center for Eco-Environmental Sciences, CAS) Zhang Yu (Research Center for Eco-Environmental Sciences, CAS) Wang Dongsheng (Research Center for Eco-Environmental Sciences, CAS) Zhang Haifeng (Research Center for Eco-Environmental Sciences, CAS) Wu Xiaoqin (Peking University)	Natural organic matter in source water: molecular composition and treatability	31
13	Molecular regulation mechanism of phase change in the migratory locust	Kang Le (Institute of Zoology, CAS) Wang Xianhui (Institute of Zoology, CAS) Ma Zongyuan (Institute of Zoology, CAS) Guo Wei (Institute of Zoology, CAS) Wang Yundan (Institute of Zoology, CAS)	Genomic analysis of phase change in the migratory locust	23
14	Study of the structure and function of Brassinosteroids and other receptor Kinases	Chai Jijie (Tsinghua University) Chang Junbiao (Zhengzhou University) Han Zhifu (Tsinghua University) Li Lei (Institute of Genetics and Developmental Biology, CAS) Song Chuanjun (Zhengzhou University)	Structural study for leucine-rich repeat receptor-like protein kinases and relative signal pathway	10
15	Promoting the regulation and physiological mechanism of rice and wheat assimilates to grain transport and grain filling	Yang Jianchang (Yangzhou University) Zhang Jianhua (Hong Kong Baptist University) Liu Lijun (Yangzhou University) Wang Zhiqin (Yangzhou University) Zhu Qingsen (Yangzhou University)	Mechanism underlying root-shoot and root-soil interactions for higher grain yield and higher water and nutrient use efficiency in super rice	22

Table 3 NSFC's Support to Awardees of the Second Prize of the State Natural Science Award in 2017 (Continued)

No.	Project Title	Principal Investigators	Projects Previously Funded by NSFC	Number of NSFC Grants
16	Cellular calcium signals and its molecular regulation	Wang Shiqiang (Peking University) Cheng Heping (Peking University) Xu Ming (Peking University Third Hospital) Wei Chaoliang (Peking University) Zhang Youyi (Peking University Third Hospital)	Mechanism and regulation of cellular calcium signals	36
17	Functional coupling between astrocytes and neurons and cerebral protection in cerebral ischemia	Wang Wei (Tongji Hospital of Tongji Medical College of Huazhong University of Science and Technology) Duan Shumin (Shanghai Institutes for Biological Sciences, CAS) Han Jing (Shaanxi Normal University) Xie Minjie (Tongji Hospital of Tongji Medical College of Huazhong University of Science and Technology) Zhang Min (Tongji Hospital of Tongji Medical College of Huazhong University of Science and Technology)	The role of astrocytes in neurovascular injury and functional reconstruction after ischemia	17
18	New mechanism of the interaction between HIV and the natural defensive factors of its parasitifer	Yu Xiaofang (Jilin University) Zhang Wenyan (Jilin University) Du Juan (Jilin University) Yu Xianghui (Jilin University) Zhao Ke (Jilin University)	New mechanism of HIV Vif mediated evasion of host restriction factors	12
19	Theory and methods on high efficiency and high mobility control of biomimetic robot fish	Tan Min (Institute of Automation, CAS) Hou Zengguang (Institute of Automation, CAS) Yu Junzhi (Institute of Automation, CAS) Cheng Long (Institute of Automation, CAS) Wang Shuo (Institute of Automation, CAS)	Research on system design and information processing of biomimetic robot fish	29
20	Research on the theory of coding aliasing imaging and computational reconstruction	Shi Guangming (Xidian University) Dong Weisheng (Xidian University) Wu Jinjian (Xidian University) Li Fu (Xidian University) Lin Jie (Xidian University)	Study on theory and technology of grabbing high resolution image/video based on irregular sampling	13
21	Analysis and control of networked dynamic systems	Wang Long (Peking University) Xie Guangming (Peking University) Xiao Feng (Peking University) Sun Yuangong (Peking University) Zheng Yuanshi (Xidian University)	Analysis and synthesis of networked dynamic systems	24
22	Basics of devices and surface/interface regulation of low dimensional semiconductors	Shi Yi (Nanjing University) Pan Lijiua (Nanjing University) Wang Xinran (Nanjing University) Hu Zheng (Nanjing University) Pu Lin (Nanjing University)	Function cooperation and device applications of semiconductor quantum structures	34

Table 3 NSFC's Support to Awardees of the Second Prize of the State Natural Science Award in 2017 (Continued)

No.	Project Title	Principal Investigators	Projects Previously Funded by NSFC	Number of NSFC Grants
23	Research on theory of predictive control and system design	Xi Yugeng (Shanghai Jiao Tong University) Li Shaoyuan (Shanghai Jiao Tong University) Ding Baocang (Xi'an Jiaotong University) Li Dewei (Shanghai Jiao Tong University) Zheng Yi (Shanghai Jiao Tong University)	Predictive control mechanism and predictive control of large systems	34
24	Fabrication and applied basic research of high quality graphene materials	Ren Wencai (Institute of Metal Research, CAS) Cheng Huiming (Institute of Metal Research, CAS) Chen Zongping (Institute of Metal Research, CAS) Wu Zhongshuai (Institute of Metal Research, CAS) Gao Libo (Institute of Metal Research, CAS)	Synthesis and Raman spectroscopy of graphene nanoribbons fabricated by chemical cutting	36
25	Structure design and property regulation of high performance photoelectrical materials and devices for utilization of solar energy	Huang Fuqiang (Shanghai Institute of Ceramics, CAS) Wang Yaoming (Shanghai Institute of Ceramics, CAS) Lin Tianquan (Shanghai Institute of Ceramics, CAS) Bi Hui (Shanghai Institute of Ceramics, CAS) Chen Lidong (Shanghai Institute of Ceramics, CAS)	Novel photoelectrical materials and thin-film solar cells	17
26	Intrinsic and extrinsic micro/nano size effect of strengthening and toughening of metal materials	Sun Jun (Xi'an Jiaotong University) Liu Gang (Xi'an Jiaotong University) Zhang Jinyu (Xi'an Jiaotong University) Yu Qian (Xi'an Jiaotong University) Shan Zhiwei (Xi'an Jiaotong University)	Deformation and damage of metal materials	25
27	Function regulation, crystal growth and giant magnetic-field-induced strain of novel magneto-elastic materials	Jiang Chengbao (Beihang University) Wang Wenhong (Institute of Physics, CAS) Wang Jingmin (Beihang University) Liu Enke (Institute of Physics, CAS) Wu Guangheng (Institute of Physics, CAS)	Preferred orientation, correlation of solidification and martensitic transformation, and multi-functions of novel magneto-elastic materials	33
28	Theory and methods of storage and transformation by multiphase flow energy-mass transmission in solar photocatalytic hydrogen production	Guo Liejin (Xi'an Jiaotong University) Jing Dengwei (Xi'an Jiaotong University) Shen Shaohua (Xi'an Jiaotong University) Su Jinzhan (Xi'an Jiaotong University) Liu Maochang (Xi'an Jiaotong University)	Research on the photocatalyst for solar photocatalytic hydrogen production	43
29	Fire preventive design and flame retarding mechanism of polymer/layered inorganic nanocomposites	Hu Yuan (University of Science and Technology of China) Gui Zhou (University of Science and Technology of China) Wang Xin (University of Science and Technology of China) Song Lei (University of Science and Technology of China) Qu Baojun (University of Science and Technology of China)	Study on the flame retarding mechanism of clean polymer/layered inorganic nanocomposites	24

Table 3 NSFC's Support to Awardees of the Second Prize of the State Natural Science Award in 2017 (Continued)

No.	Project Title	Principal Investigators	Projects Previously Funded by NSFC	Number of NSFC Grants
30	Nonlinear modeling and vibration analysis for rigidity-flexibility interaction in high-speed motion system	Yang Shaopu (Shijiazhuang Tiedao University) Chen Liqun (Shanghai University) Li Shaohua (Shijiazhuang Tiedao University) Shen Yongjun (Shijiazhuang Tiedao University) Ding Hu (Shanghai University)	Nonlinear dynamics of high dimensional heavy vehicle-pavement coupled system	32
31	New method of remediation of refractory organics and heavy-metal polluted wetland by functional nano-materials and organisms	Zeng Guangming (Hunan University) Gong Jilai (Hunan University) Huang Danlian (Hunan University) Tang Lin (Hunan University) Liu Yunguo (Hunan University)	Remediation of the polluted wetland for lakes	18
32	Fracture mechanics of functionally graded materials	Wu Linzhi (Harbin Institute of Technology) Zhou Zhengong (Harbin Institute of Technology) Guo Licheng (Harbin Institute of Technology) Ma Li (Harbin Institute of Technology)	Low-cost preparation and mechanical properties of metallic lattice truss structures	20
33	Wall slip behavior and mechanical model of van der Waals layered medium	Zheng Quanshui (Tsinghua University) Liu Zhe (Tsinghua University) Xu Zhiping (Tsinghua University) Liu Ze (Tsinghua University) Liu Yilun (Tsinghua University)	Mechanics and invention of van der Waals nanoelectromechanical devices and systems	29

Table 4 NSFC's Support to Awardees of the First Prize of the State Technological Invention Award in 2017

No.	Project Title	Principal Investigators	Projects Previously Funded by NSFC	Number of NSFC Grants
1	Development and application of key technology for ultra-low emissions of coal-fired units	Gao Xiang (Zhejiang University) Wu Guochao (Zhejiang Energy Group Co., Ltd.) Zhu Songqiang (Zhejiang Energy Group Co., Ltd.) Zheng Chenghang (Zhejiang University) Hu Daqing (Zhejiang Tiandi Environmental Protection S&T Co., Ltd.) Cen Kefa (Zhejiang University)	Intelligent optimization control theory and key technology for ultra-low emissions of coal-fired flue gas pollutants	11
2	Technology and equipment for high-quality and high-efficiency processing of high-performance carbon fiber composite component parts	Jia Zhenyuan (Dalian University of Technology) Gao Hang (Dalian University of Technology) Wang Fuji (Dalian University of Technology) Bao Yongjie (Dalian University of Technology) Li Lanzhu (Aerospace Research Institute of Materials & Processing Technology) Liu Jianbo (Harbin Aircraft Industry Group Co., Ltd.)	High precision and efficiency machining principles for inner curved surfaces of high performance parts by viscoelastic abrasive flow media	17

Table 5 NSFC's Support to Awardees of the First Prize of the State Scientific and Technological Progress Award in 2017

No.	Project Title	Principal Investigators	Host Organizations	Projects Previously Funded by NSFC	Number of NSFC Grants
1	±800kV extra-high voltage direct current transmission system	Li Licheng, Liu Zhenya, Shu Yinbiao, Liu Zehong, Shang Tao, Li Xiaolin, Gou Ruifeng, Ma Weimin, Huang Ying, Lu Jianqiu, Wu Baoying, Lu Jiayu, Wang Jian, Mi Chuanlong, Zhou Yuanxiang, Yin Yonghua, Luo Bing, Zhang Xile, Liang Zhengping, Gao Liying, Cai Xipeng, Zhang Yuehua, Yu Yongqing, Wang Jiansheng, Yu Jun, Hong Chao, Liang Yanqiao, Chen Dong, Lyu Jinzhuang, Qi Lei, Li Xia, Peng Zongren, Wang Qi, Li Zheng, Zhang Wanrong, Hu Rong, Lu Licheng, Yu Bo, Ma Bin, Sima Wenxia, Li Haiying, Fang Senhua, Dang Zhenping, He Zhi, Chong Zhiyi, Xue Chunlin, Zheng Jin, Guo Zhenyan, Feng Xiaodong, Tang Xiaozhong	State Grid Corporation of China, China Southern Power Grid Company Limited, China XD Group Company Limited, China Electric Power Research Institute, Southern Power Grid Research Institute Company Limited, State Grid Beijing Economic and Technological Research Institute Company Limited, Xi'an Power Electronics Research Institute, TBEA Shenyang Transformer Group Company Limited, Tsinghua University, Nanjing Nanrui Electric Company Limited, Electric Power Planning & Engineering Institute Company Limited, Baoding Tianwei Baobian Electric Company Limited, Xujii Group Corporation, Xi'an XD Transformer Company Limited, North China Electric Power University, Xi'an XD Power Systems Company Limited, Central Southern China Electric Power Design Institute Company Limited of China Power Engineering Consulting Group Corporation, Southwest China Electric Power Design Institute Company Limited of China Power Engineering Consulting Group Corporation, East China Electric Power Design Institute Company Limited of China Power Engineering Consulting Group Corporation, China Energy Engineering Group Guangdong Electric Power Design Institute Company Limited, Northwest Electric Power Design Institute Company Limited of China Power Engineering Consulting Group Corporation, Beijing Power Equipment Group Company Limited, Xi'an Jiaotong University, Chongqing University, Jiangsu Shemar Electric Company Limited, Dalian Insulator Group Company Limited, Guilin Power Capacitor Company Limited, Machinery Industry Beijing Electrotechnical and Economic Research Institute, Fushun Hi-Tech Electric Porcelain and Electricity Manufacturing Company Limited, Zibo Taiguang Electrical Equipment Company Limited	Electrical treeing mechanism of silicone rubber in extra high voltage prefabricated cable accessories	11

Table 5 NSFC's Support to Awardees of the First Prize of the State Scientific and Technological Progress Award in 2017 (Continued)

No.	Project Title	Principal Investigators	Host Organizations	Projects Previously Funded by NSFC	Number of NSFC Grants
2	Major innovation and technological breakthrough on prevention and control system against emerging infectious diseases: as in the prevention and control of human infection with H7N9 virus	Li Lanjuan, Shu Yuelong, Guan Yi, Feng Zijian, Yuan Guoyong, Gao Fu, Yuan Zhenghong, Wang Yu, Yu Hongjie, Wang Dayan, Gao Hainyu, Wang Chen, Zheng Shusen, Yang Shigui, Yang Weizhong, Cao Bin, Chen Honglin, Li Qun, Zhu Huachen, Zhou Jianfang, Liu Di, Gao Rongbao, Wu Nanping, Hu Yunwen, Yao Hangping, Zhang Xi, Yu Liang, Zheng Shufa, Wu Fan, Lu Hongzhou, Wang Jia, Xia Shichang, Cui Dawei, Bai Tian, Liang Weifeng, Lin Zanyu, Wu Guizhen, Jie Zhijun, Guo Jing, Du Qihong, Sheng Jifang, Diao Hongyan, Xiang Nijuan, Yang Yida, Zhao Xiang, Tang Lingling, Zou Shumei, Yu Fei, Zhu Danhua	The First Affiliated Hospital of Zhejiang University School of Medicine, National Institute for Viral Disease Control and Prevention of Chinese Center for Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Shantou University, University of Hong Kong, Fudan University, Institute of Microbiology of CAS, Shanghai Municipal Center for Disease Control and Prevention, The Fifth People's Hospital of Shanghai, Beijing Chao-yang Hospital of Capital Medical University, Zhejiang Provincial Center for Disease Control and Prevention	Characteristics of H7N9 binding to its receptors	92

Part V

Introduction of Selected Projects of National Natural Scieece Fund Completed in 2017

5.1 Major Research Plan

The epigenetic mechanisms of cell programming/ reprogramming

The Major Research Plan "The epigenetic mechanisms of cell programming/reprogramming", granted 155 awards with a total funding of nearly 19 million yuan, including 68 awards in nurturing project (42.39 million yuan), 23 awards in key supporting projects (47.8 million yuan), 59 awards in integration projects (99 million yuan) and 5 awards in strategic research projects (10.81 million yuan). Professor Pei Gang from Tongji University, member of CAS, took the leadership of the Guidance Expert Committee and more than 700 domestic as well as overseas researchers from 43 institutes or universities joined this program.

In this program, multidisciplinary approaches have been adopted to discover the rules and characteristics of epigenetic information establishment, maintenance and function during cell programming/reprogramming; to elucidate the epigenetic mechanisms involved in cell proliferation, differentiation, development and environmental adaptation; and to reveal the composition, evolution and operation of the whole epigenetic network. Such in-depth study of epigenetics improved the original innovation capability and international influences of Chinese basic life science research, helped to solve problems in human health and agricultural production.

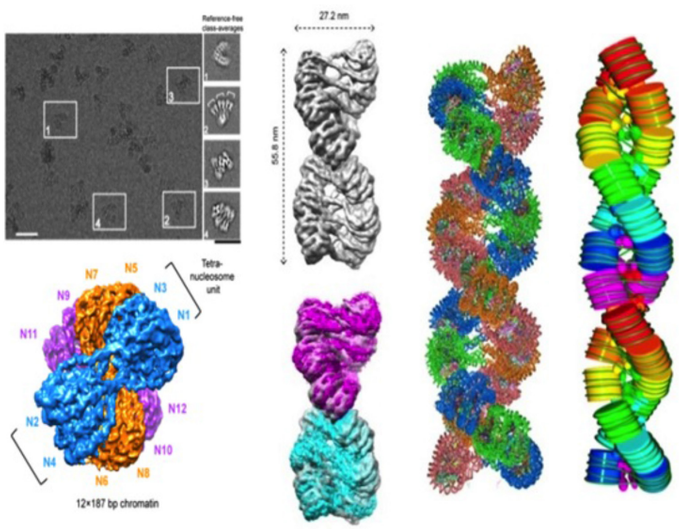


Figure 1. analysis of hogher-order chromosomal structure

The program achieved series of breakthroughs with major international implications, including:

1. Breakthroughs in elucidation of epigenetic regulation mechanisms, especially unraveling the higher-order chromatin structures of 30 nm chromatin fiber (Figure 1).

2. Establishment of haploid embryonic stem cells and semicloned technology, discovery of new regulatory theories and techniques in somatic cell reprogramming.

3. Fruitful findings in understanding cell differentiation/trans-differentiation, embryonic development and disease related epigenetic mechanisms.

4. Achievements in establishing DNA methylome in various species and depiction of

the origin and evolution of epigenetic landscape.

With the funding of the research program, 815 research papers were published in international authoritative academic journals, including top journals such as *Nature* (8), *Science* (2), *Cell* (11), *Nature* Series (38), *Cell Stem Cell* (11), *Cell Research* (46) and *PNAS* (25). The talented finding, "Structures of 30 nm chromatin fiber", has been written in the recent version of international mainstream textbooks, "Lehninger Principles of Biochemistry" and "Fundamentals of Biochemistry". 37 international patents were applied and several outstanding honors were awarded, including State Natural Science Award (2nd class, 2), State Scientific and Technological Progress Award (1st class, 1; 2nd class, 4). Four research findings achieved the honors of The Ten Major Advances in Science and Technology in China.

Under the program's funding, many outstanding Chinese scientists in the field of epigenetics and cell-fate determination are fostered, who now represent the top level of the field in the world. 4 people from the Guidance Expert Commit become CAS members due to their excellent performance. 15 and 16 researchers within this program were funded by Excellent Young Scientists Fund and National Science Fund for Distinguished Young Scholars, respectively. 9 researchers were funded by Science Fund for Creative Research Groups.

In the future, several interesting directions need to be further addressed to strengthen the international standing of China in the epigenetic field, such as epigenetic inheritance responding to the environmental signaling, the dynamic regulation of the higher-order nuclear chromatin structure, the epigenetic information analysis in single-cell level, the gene editing by epigenetic modification and epigenetic transcriptome, etc.

Destruction of North China Craton

In order to achieve the proposed scientific goals, 66 subject and integration projects were carefully designed, with the total budget of 200 million yuan. Among them, there are 8 projects relating to structural geology with budget of 18.4 million yuan, 13 projects of geophysics with budget of 45.85 million yuan, 17 petrological and geochemical projects with budget of 39 million yuan, 11 projects dealing with natural resources and disasters with budget of 29.102 million yuan, 7 experimental and simulation projects with budget of 14.9 million yuan, and 10 integration projects with budget of 52.748 million yuan. More than 686 key researchers from 40 research institutions and universities were involved in this project, in which there are 10 foreign research units and 13 overseas scholars.

The main research contents consist of: (1) multidisciplinary observations of geology, geophysics and geochemistry on the North China Craton and its adjacent areas; (2) the nature and mechanism of cratonic destruction, including the spatial-temporal distribution of cratonic destruction and its surface response, lithospheric changes in compositions and physical properties, the influence of the subduction of the Paleo Pacific plate on the North China Craton and its dynamic mechanism; (3) the resources and biological effects of cratonic destruction, how the destruction of North China Craton controlled the formation of gold deposits, the preservation of oil and gas, as well as the terrestrial biota; (4) the accumulation and sharing of basic data, compilation of key geologic, geophysical and geochemical maps based on multidisciplinary integration research, establishment of a 3D speed structure database and usage system.

All the design goals were achieved. A new concept of "cratonic destruction" was put forward, the spatial-temporal distribution of cratonic destruction was well constrained, the processes and mechanism of cratonic destruction were delineated, and on this basis, a new theory of cratonic destruction was created, which revealed the significant role of the destruction of North China Craton in understanding the global continental evolution, and further developed the plate tectonic theory.

Some key scientific issues such as the spatial-temporal distribution, processes and mechanism of the destruction of North China Craton have been solved.

The representative achievements are: (1) put forward a new concept of "cratonic destruction", which revealed that the changes in chemical compositions and properties of the lithosphere are the key factors leading to the destruction of the North China Craton; (2) confirmed that the eastern part of the North China Craton had been totally destructed, while the western part is still being stable and the central zone was partially modified. The peak time of destruction of North China Craton was in early Cretaceous (~1.25 Ga); (3) demonstrated the dynamic mechanism of the destruction of the North China Craton, namely, the subduction of the Paleo-Pacific plate in the Early Cretaceous is the first-order external controlling factor and driving force that led to the destruction

of the NCC, and that deep dehydration of the subduced slab resulting in unsteady mantle flows, partial melting and weakening of the overlying lithospheric mantle; the subducting plate rotation and subduction zone retreat led to strong extension of the lithosphere; the combined effects of these factors made the change of lithospheric mantle properties, resulting in the destruction of the North China Craton.

This Major Research Plan is a successful example of exploring the frontier of geoscience by using China's regional advantages. It has made the destruction of the North China Craton a hot spot in global solid earth science, taking China's solid earth science research into the forefront of the world. The implementation of the plan has spawned new frontiers of disciplines, such as (1) craton destruction and terrestrial lift evolution, (2) deep processes and metallogenic mechanism of the North China Craton metallogenic system, (3) major geological events and metallogenic effects in the Yanshanian, and (4) Tethys earth dynamic system. These researches will lead Chinese scientists to become the leader of future international major research program, realizing the leap of China from a big country to a great power in geoscience.

Basic research of trustworthy software

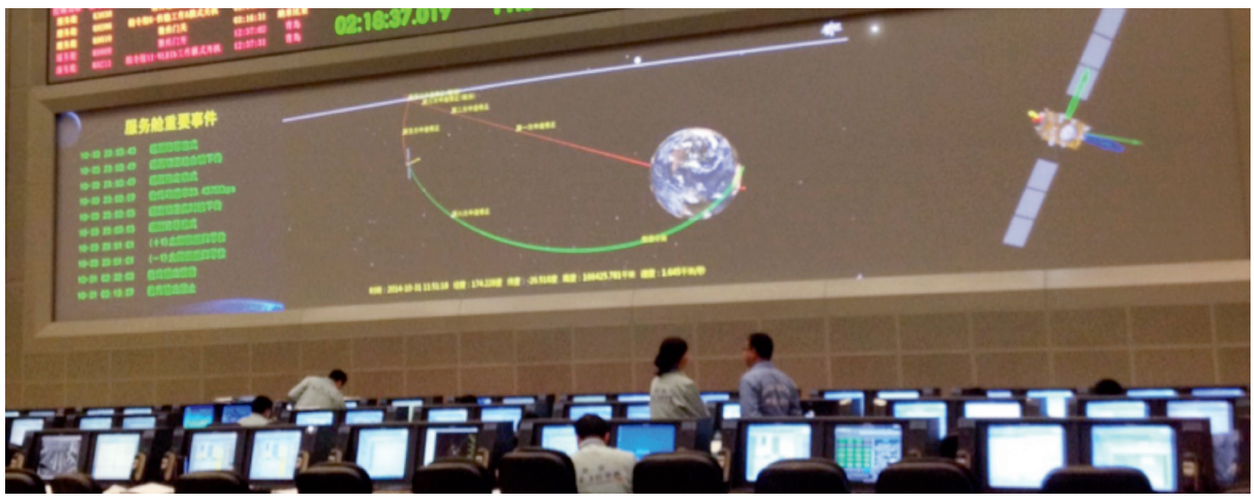


Figure 1. "Lunar exploration project phase III" space flight control center command hall in Beijing.

The Major Research Plan "Basic research of trustworthy software" started in January 2008. The Plan has funded a total of 102 research projects, i.e., 73 elementary projects, 24 key projects and 5 integration projects, with a total funding of 190 million yuan. Professor He Jifeng (member of CAS) of East China Normal University is the leader of the Plan's steering expert group.

The Plan focused on the issue of software trustworthiness in national key application. During the implementation of the Plan, the researchers revealed the basic rules of software trustworthiness and environmental trustworthiness's measurement and evolution, and established a set of methodologies and key technology architectures for productively constructing, verifying and evolving trustworthy software. The researchers have also built trustworthy software development tools and operational support platforms and environments, and justified, evaluated the effectiveness and efficiency of the outcomes in the nation-wide scale embedded and networked software systems. The Plan has provided a strong scientific support to improve software trustworthiness in major national software projects.

The Plan systematically investigated the four core scientific challenges: modeling and prediction of software trustworthiness, construction and verification of trustworthy software, evolution and control of trustworthy software, construction and evaluation of trusted computing environment. The researchers developed and established a number of tools and integrated environments (platforms) for practical software trustworthiness construction and verification. Taking embedded software and large-scale network-based software applications as the breakthrough point, the researchers have conducted a number of

demonstration applications for safety-related software in aerospace (as shown in Figure 1), car networking, taxation, and finance industries. An aerospace embedded software trustworthiness assurance integrated environment was developed, an information service platform and a big data cloud service platform for car networking were established, an electronic taxation trusted monitoring tool was developed, and the first Internet transaction risk prevention and control system in China was established.

The Plan realized the leap of software from the traditional simplex measurement theory to the comprehensive reliability measurement theory and its construction method. It systematically promoted software and the operating environment to become behavior trustworthy, environment trustworthy, usage trustworthy, and process trustworthy. It realized the transformation of software from traditional correctness to trustworthiness in an open, dynamic and changeable environment. The application scale and benefits in several fields are at the international level. The implementation of the Plan had promoted the original innovation ability in the field of trustworthy software, provided scientific support for major national projects, cultivated high-level research teams, and promoted the development of China's software industry. The Plan had completed the predetermined research task, reached the scientific goal, and laid a solid foundation for the follow-up research work.

The information society is steping into a new era of three-dimensional integration of human-machine-material, with Internet and its extension as the infrastructure, with big data and its application as the important feature. In the future, the basic research field of trustworthy software should further highlight the research on the trustworthiness of software meta-theory, continue to strengthen research on the combination of formal and data-driven trustworthy software technology, and focus on the integration of trustworthy software and artificial intelligence in cross-disciplinary research, to achieve the human-machine-material integrating trustworthy software systems driven by demand.

5.2 Special Fund for Research on National Major Research Instruments

Terahertz superconducting imaging array (TeSIA)

The "Terahertz Superconducting Imaging Array (TeSIA)" project is one of nine projects grant by Special Fund for Research on National Major Research Instruments, which initiated in 2011. The total funding for the TeSIA project is 60 million yuan and the period covered is from January 2012 to December 2016. The TeSIA project is led by Professor Shi Shengcai of the Purple Mountain Observatory, CAS.

The terahertz band is the latest development in the 21st century for mankind to explore the universe, playing an increasingly important role in the frontiers of contemporary astronomy such as the origin of life in the universe and early universe of high redshift. China is planning to build a 5-meter terahertz telescope (DATE5) at Dome A in Antarctic, which offers the best access to atmospheric windows at THz/FIR wavelengths on the earth. The first-generation instrument for the DATE5 telescope will be two multi-beam superconducting heterodyne receivers dedicated to observations of molecular and atomic spectral lines at 350 μm and 200 μm. Furthermore, the DATE5 telescope needs to be equipped with a multi-pixel wide-field THz camera to carry out large-scale legacy survey for understanding the THz/FIR radiation properties of the building blocks of our universe. The TeSIA project was therefore proposed to address this important scientific goal. The project task is to develop a 32×32-pixel superconducting imaging array for the 350 μm band (i.e., 0.85-THz band) with its sensitivity reaching the background limit for ground-based telescopes, that is, the noise equivalent noise power NEP < 0.1 fW/Hz 0.5. The TeSIA consists of a cryogenic optical unit, a large-format superconducting detector array unit, a cryogenic readout unit, a data acquisition and control

Figure 1. The 32×32 superconducting imaging array system for the 350 μm band.

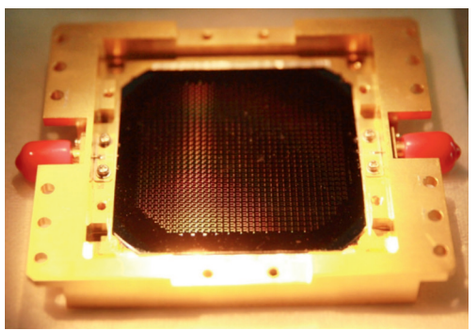


Figure 2. The 32×32 superconducting KID detector for the 350 μm band.

unit, and a 0.3 K cryogenic cooling unit. After five years of efforts, the team has successfully developed the core technology of the project—Kinetic Inductance Detectors (KIDs) and Transition Edge Sensors (TES) 2D array—for the first time in China, including array design, fabrication and characterization. The KID detector chip demonstrates as good performance as the most advanced KID detectors in the world in terms of the pixel size, sensitivity and working frequency. In addition, the team has developed some key technologies such as the frequency-domain multiplexing readout for large-format KID detector arrays, simulation kit for THz imaging optics with large FOV, and sub-K cryogenic refrigeration platform. Based on the developments mentioned above, the team built an 8×8 pixel at 850 μm and a 32×32 pixel at 350 μm superconducting imaging arrays, reaching background-limited sensitivity. Two superconducting imaging array systems have been used for astronomical testing observation and laboratory demonstration, respectively. Successful development of this project makes China among the forefront in the field of large-format superconducting detector technology and provides a powerful THz imaging technology for China's radio telescopes. Besides the application on the DATE5 telescope, the KID and TES detector technologies will also find good performance in the fields of CMB, 3D spectro-imaging, X-ray and optical infrared astronomy, and quantum information.

Research on spherical focused ultrasound therapeutic system

Figure 1. Spherical focused ultrasound therapeutic system.

The project has been undertaken for 5 years with total funding of 60 million yuan, mainly covering the following sections:

1. Theoretical study: in order to explore a new method to spherically focusing standing wave, relevant theories about how to achieve109 Pa high acoustic pressure were studied.

2. Research on and development of scientific instruments: researches were undertaken on core technologies for pressure resistant spherical focused transducer, high power supply, water treatment system, underwater optical fiber moving device with higher degree of freedom; we have developed three spherical focused ultrasound systems operating under different external pressures (10M Pa maximum).

3. Measurement of ultrahigh acoustic pressure: all quartz Fabry-Perot (F-P) optical fiber system for measuring high acoustic pressure has been developed, which surpasses the measuring capacity of existing hydrophones and can measure acoustic pressure as high as 109 Pa.

4. Study of biological effects: relevant studies were conducted to compare the biological effects produced by spherically focused standing wave and traditional focused travelling wave, and the corresponding impacts on the effectiveness and safety of ultrasound ablation, focal shift of ultrasound, and monitoring complexity.

5. Researches on the newly detected phenomena in relation to the equipment: sonoluminescence and strong cavitation of focused transducer within the focal region were investigated.

6. Researches on the application of ultrasound in other fields: researches were done on utilizing ultrasound to emulsify diesel, smash single crystalline diamond, cut tungsten wire or stainless steel wire.

This part of the project has come to fruition, with the successful development of large-

diameter spherical focused transducer, high ultrasonic power generator, high acoustic pressure detector, three spherical focused ultrasound systems that can bear operating under different external pressures (10M Pa at most).

Table 1 Parameters and Features

Core parameters of the instrument	
Maximum acoustic pressure at the focus	≥1.0×10^9 Pa
-6 dB focal region	Axial direction < 0.8 λ radial direction < 0.6 λ
Interior diameter of the spherical transducer	800 mm
Acoustical power	20k W
Working pressure	≥10M Pa

The instrument can generate the highest acoustic pressure recorded in the world, with the fine focal region reaching sub-wavelength, which is a breakthrough in acoustics and extreme condition physics instrument. This project provides a novel method for studies in physics, chemistry, material science and other disciplines. It may also help to give rise to a new discipline: acoustic physics.

This instrument, the first of its kind in the world, is an original innovation protected by proprietary intellectual property rights. It is capable of generating the highest acoustic pressure recorded globally.

Research outcomes:

1. New method for the spherical focusing of standing wave was proposed. Theoretical model for mesoscopic non-linear sound propagation was further developed. Theoretical framework for realizing 109 Pa high acoustic pressure was primarily created.

2. Technological breakthroughs were made in designing and manufacturing large-diameter spherical focused transducer and high power driving source with low load impedance (< 0.3 Ω). The first original innovative spherical focused ultrasound system protected by proprietary intellectual property rights was successfully developed.

3. Fabry-Perot (F-P) optical fiber system for measuring high acoustic pressure protected by proprietary intellectual property rights was successfully developed. It can repeatedly measure 109 Pa ultrahigh acoustic pressure and sub-wavelength fine focal region.

4. The biological effects produced by spherically focused standing wave can damage the lesion more effectively and be monitored more easily, which cannot be realized with traditional focused travelling wave.

5. Exploring the new phenomena observed in the process of implementing, this project has

resulted in a number of new findings and original innovations, including 114 papers published in SCI-indexed journals, 9 foreign and domestic academic conference presentations, and 3 academic monographs. In addition 48 patents for invention were authorized, including 29 Chinese invention patents and 19 international ones. Another 15 new Chinese invention patents are being applied for, and 5 international, Chinese, and local industry standards were made or revised. And 132 master students, 43 doctoral students and 1 postdoctoral researcher were trained. With all these achievements, the project has come to a successful completion.

Part VI

International (Regional) Cooperation and Exchange

In 2017, NSFC continued to carry out international (regional) cooperation and exchange (hereinafter "cooperation and exchange") in line with the overall planning to make the Foundation increasingly international. In connection with its works, NSFC remains proactive in pushing forward with international scientific collaboration under the framework of the Belt and Road Initiative, by engaging in more bilateral and multilateral cooperation programs and striving for better results in both foreign visits and receiving international guests. The Foundation has reflected on the international cooperation in big-picture terms and made proactive planning for its works in all aspects.

1. Convening the Belt and Road International Symposium to discuss the building of scientific collaboration network among the B&R Countries

NSFC's cooperation and exchange is aimed at building up China's scientific strength and serving the national diplomacy with Chinese characteristics. In a bid to implement the overarching Belt and Road Initiative proposed by the General Secretary Xi Jinping, NSFC hosted the International Symposium on Funding Science and People Cooperation for a Prosperous Belt and Road, which gathered leaders and representatives from research funding institutions in over 30 countries and regions and from international organizations. The attendees agreed on *the Joint Declaration on Funding Science and People Collaboration for a Prosperous Belt and Road*, which paved the way for setting up "the Belt and Road Funding Framework for Science and People Collaboration" (BRFF). In the press conference after the Symposium, NSFC briefed the public on the strategic significance of the BRFF, its initiative conception and the

Figure 1. On July 4, 2017, NSFC held a press conference on the International Symposium on Funding Science and People Cooperation for a Prosperous Belt and Road.

perspectives of international representatives on the Joint Declaration and the BRFF.

In 2017, the Foundation continues to expand its network of collaboration with entities in countries and regions along the Belt and Road routes. It signed cooperation MoUs with the Iran National Science Foundation (INSF), the Mongolian Foundation for Science and Technology (MFST) and Shota Rustaveli National Science Foundation (SRNSF) in Georgia; renewed cooperation agreements with Egypt's Academy of Scientific Research and Technology (ASRT) and the Belarusian Republican Foundation for Fundamental Research (BRFFR); and signed NSFC–ISF Joint Research Program Agreement (2018–2021) with the Israel Science Foundation (ISF), which was included in the results list of the third Sino-Israeli Joint Committee for Innovation Cooperation, co-chaired by the then Vice Premier Liu Yandong and Israeli Premier Nethanyahu. In addition, the Foundation and the National Science Centre (NCN) in Poland built on the existing framework agreement and reached consensus on jointly identifying and funding joint research programs across the board. NSFC and the National Science Foundation (NSF) of Sri Lanka agreed to begin identifying joint research programs, in a bid to provide China's solution for important issues related to the livelihoods of the people in Sri Lanka. NSFC, in partnership with National Research Council of Thailand (NRCT), the Thailand Research Fund (TRF) and the National Research Foundation (NRF) in Singapore, has started funding for joint research programs.

In 2017, the Foundation signed 3 cooperation agreements with B&R Countries, bringing the total number of agreements with such countries to 21, 23.1% of all cooperation agreements signed. Last year, NSFC offered 1.3401 trillion yuan to fund 68 substantial joint programs between China and B&R Countries and invested 1.1082 million yuan to fund 42 joint exchange programs. On top of that, the Foundation also provided funds for 71 international young scientists from B&R Countries.

2. More high level meetings to deepen strategic relations

The Foundation continues to attach importance to mutual visits by senior officials so as to deepen strategic partnerships and improve top-level designing. In mutual visits, the Foundation looks to enhance old and build new ties with other research funding institutions. As a result of its efforts, bilateral and multilateral relations have been deepened.

NSFC organized 20 international visits for senior officials. In May, President Yang Wei visited Canada for the 2017 Annual Meeting of the Global Research Council (GRC). In June, he paid visits to the National Research Council (CNR) in Italy as well as to FAO, the National Center for Scientific Research (CNRS) in France, the French National Research Agency, the National Hellenic Research Foundation (NHRF) and the General Secretariat of Research and Technology (GSRT) in Greece. In October, Vice President Shen Yan visited the Israel Science Foundation (ISF) and attended NSFC-ISF Bilateral Workshop on Quantum Technology. Vice President He

Minghong in September visited China's Hong Kong to attend the 2017 Innotech Expo and the Hong Kong Innovation and Technology Forum 2017. In March 2017, Vice President Liu Congqiang led a delegation to New Zealand and signed cooperation documents with the Health Research Council (HRC). In April, he led another group to visit INSF in Iran and SRNSF in Georgia. In May, a delegation was led by him to go to the Royal Society of Edinburgh (RSE) in the UK and the Swiss National Science Foundation. In September, he attended the ASIAHORCs Meeting in Japan and led a delegation to pay visits to Norway, Poland and Hungary. In October, he was in the ROK for the 15th meeting of A-HORCs and for a National Research Foundation (NRF) International Forum which marked the NRF's 40th anniversary. Vice President Gao Wen visited the US to attend an ACM Council Meeting and paid a visit to Cornell University. Vice President Gao Ruiping was in Japan in May to take part in the 2017 Gender Summit and went Australia in October for a China–Australia symposium on advanced materials.

In 2017, NSFC received 28 visits from high-level leaders, including president of the ERC Professor Jean-Pierre Bourguignon, Deputy Secretary General of the DFG Professor Harald von Kalm, President of the RSE Professor Dame Jocelyn Bell Burnell, President of the CONICYT Mario Hamuy, Minister for Higher Education and Research in Sweden Helene Hellmark Knutsson, Director General & CEO of IIASA Professor Pavel Kabat, President of MFST Dr. Damdin Enkhjargal, INSF President Professor Nosratollah Zargham, Executive Director of SRNSF Professor Manana Mikaberidze, President of BRFFR Sergey Gaponenko, President of NSF Professor Sirimali Fernando, CEO of NRF Professor Low TeckSeng, Dean of CUHK Professor Joseph Jao-Yiu Sung and President of FDCT Dr. Ma Chi Ngai Frederico.

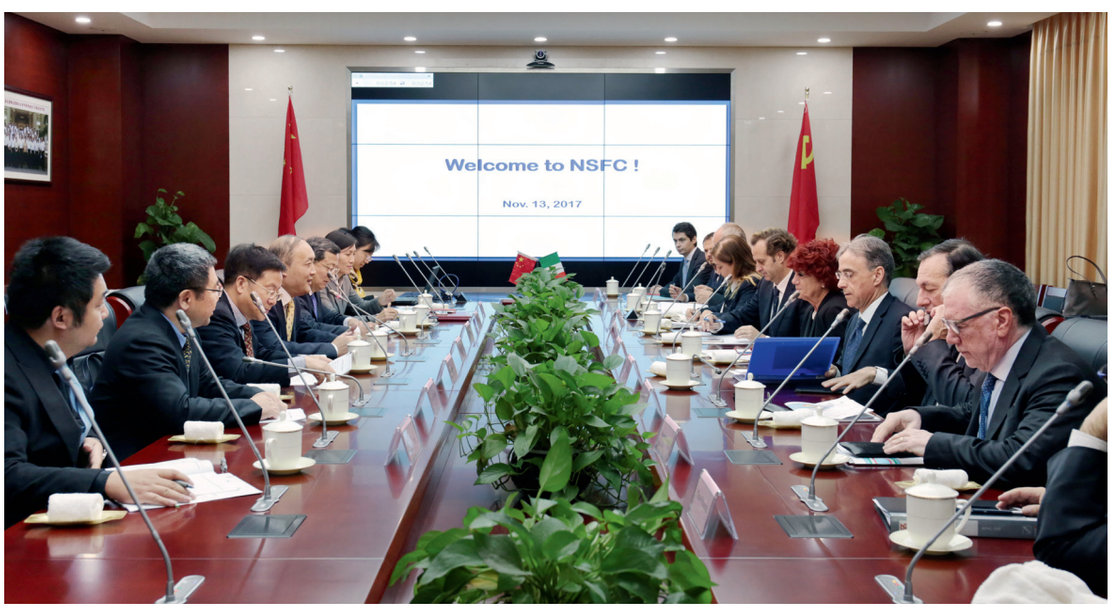


Figure 2. On November 13, 2017, President Yang Wei met with an Italian delegation led by the Minister of Education, University and Research of Italy.

3. Receiving, reviewing and managing the cooperative programs with international institutions, and strengthening the substantial international cooperation

Cooperating with overseas science foundations and international R&D funding institutions is a major means for NSFC to realize the strategic goal in the international cooperation. In 2017, the Bureau of International Cooperation has actively promoted the cooperation and exchanges with international counterparts, especially the cooperation with technologically advanced countries, including the U.S., Canada, the U.K., France, Japan, Korea, Israel and Singapore, international institutions and bordering countries. It has received 5,604 applications for the international cooperation and exchange programs and dealt with 5,047 applications. Under the review and assessment of experts, 1,175 programs have been approved with 1.07 billion yuan subsidies. In terms of subsidizing the cooperative researches between different organizations, it subsidizes nearly 700 million yuan for 30 batches and 370 cooperative research programs in total with 27 funding and research institutions. It subsidizes 17 batches and 180 cooperative exchanges programs in total with 15 funding and research institutions. In addition, it has funded 41 batches and 320 multiple/ bilateral conferences with 38 funding and research institutions.

In 2017, the program for subsidizing talents has been finished. The applications for Research Fund for International Young Scientists have increased gradually. 391 additional applications for new programs have been submitted, an increase of 62.9% over the level of 2016 (240 programs). After review and assessment, 146 programs have been approved with the direct funding of 42.6727 million yuan. 22 extension applications have been dealt with. After review and assessment, 9 programs have been approved with the direct funding of 2.3273 million yuan. Real breakthrough has been made in developing high-end and international talents under the cooperation of China and the U.K., and China and Europe. In 2017, the subsidy for the third batch of a total of 13 Newton Talent Projects has been achieved. NSFC and European Research Council (ERC) have successfully called for the second batch of talent training programs. The Chinese researchers, under the sponsorship of NSFC, have been selected for the top European project team subsidized by the ERC to conduct cooperative and mutually beneficial research in the related domain of science. NSFC actively uses international organizations to develop talents. The cooperation with International Centre for Theoretical Physics (ICTP) has been finished successfully for funding 31 young scientists to participate in the academic activities in Italy organized by ICTP. Through the Hope Meeting, NSFC has selected and funded 10 young scientists to participate in the lecture of the Nobel Prize winners and exchange ideas with those great thinkers. NSFC funds 7 young scientists to participate in the IIASA's Young Scientists Summer Program (YSSP).

4. Strengthening study and investigation on international (regional) cooperation strategies and conducting cooperation based on different countries, and regional advantages and characteristics

NSFC promotes policy research through Shuangqing Forum. In May 2017, NSFC held the 176th "Shuangqing Forum" with the theme of "Exploration on the Funding Model of the International Cooperation Center in Basic Sciences". Professor Yao Tandong (CAS member) from Institute of Tibetan Plateau Research, CAS, chaired the forum. 25 experts, scholars and managers from 23 scientific research institutions, universities and colleges and authorities attended the forum. The forum fully discussed the meaning, role and funding models of the "international cooperation center programs in basic sciences". The constructive suggestions from experts were of strategic guiding meaning for the establishment of the future international cooperation centers in the basic sciences.

In 2017, based on different countries, and regional advantages and characteristics, NSFC cooperated with various partners. In the North America, it has continuously promoted the cooperation with the U.S. and Canada through actively finding common interest and gradually improving cooperation scale and level in the global healthcare and environment aspects. It has funded the network system together with National Science Foundation (NSF) on "Innovative research on food, energy and water", which marked the first 3-year cooperation program for NSFC toward the U.S. Under the framework of Global Alliance for Chronic Diseases (GACD), NSFC has started 5-year cooperation with Canadian Institutes of Health Research (CIHR) in the aspect of mental health. Also, it has initiated the first academic exchanges with Le Fonds de Recherche du Quebec (FRQ) in the "Smart cities".

In Europe, NSFC has set up a scientific cooperation and exchange network and platform, which prioritizes comprehensive countries in Europe, including the U.K., German, France, Russia and the EU, ranges from multiple levels and covers wide aspects. The scientific cooperation and exchange network and platform is featured by its advantages in the Netherland, Sweden, Finland, Denmark, Switzerland, Portugal, Italy, Ireland, Norway and other countries, and is complemented by the cooperation in the specialized areas. In 2017, NSFC and RCUK have implemented 3 rounds of bilateral and multilateral cooperation in the offshore renewable energy, sustainable delta and animal health. In the final 2 rounds, Netherlands Organization for Scientific Research (NWO) and foundations from Philippines and Thailand have participated. Both sides held seminar for antibiotic resistance and invited representatives from 7 research councils. NSFC has started its first research cooperation program with DFG through top-down application for comprehensive researching fields, which aroused great interest of the Chinese and Germany scientists. 582 applications, which set a new record, were received and 131 funding programs were approved. The amount of application and grants for the Chinese and Germany cooperation programs ranked the top among all the cooperation programs, laying

a solid foundation for the further cooperation between two sides. Besides, NSFC started its first joint funding program with Science Foundation Ireland (SFI) and Ministry of Foreign Affairs and International Cooperation of Italy (MAECI). It has renewed its Memorandum of Understanding with Norwegian Research Council (RCN) and Research Foundation Flanders (FWO).

In Asia, it continues to stabilize and deepen the bilateral cooperation with four leading technology powers, including Israel, Japan, Korea and Singapore. Under the framework of China-Israel Joint Commission on Innovation and Cooperation, NSFC maintains its cooperation with Israel on a larger scale. As a member of China-Israel Joint Commission on innovation and Cooperation, China-Singapore Joint Commission on Innovation and Cooperation, NSFC improved its influence through participating in the intergovernmental joint commissions and conducting top-down design for bilateral cooperation. China Korea Joint Commission on Basic Science Research provides the institutional guarantee for the China and South Korea cooperation. The regional cooperation mechanism among China, Japan and South Korea became the important joint funding plan. Heads of Research Councils in Asia (A-HORCs) helped and guided the cooperation among three countries through making strategies.

In Australasia, NSFC has renewed its Memorandum of Understanding with Health Research Council (HRC) of New Zealand and has been listed as one of the major achievements for Premier Li Keqiang to visit New Zealand.

5. Actively participating the multilateral, regional and global cooperation and serving for the national diplomacy with Chinese characteristics

In 2017, NSFC explored multilateral cooperation moded, promoted multilateral cooperation, and enhanced country's power. It established co-funding with Cuba and Canada. Under the framework of the document by the DG-RTD, administrative work for summoning Cooperative Research Project, a funding plan was passed. The ERA-net "Urban European Cooperation Project Plan" was used to carry out the joint solicitation and subsidy work for the China-EU Variant Cooperative Research Project, and a cooperation agreement was signed on this. It conducted multilateral cooperation with UNEP, CGIAR, ICOMOD, ICTP and so on. Participation in cooperation with BRIC countries' science, technology and innovation framework programs helped to serve national diplomacy. In addition, Professors Fu Bojie (CAS member) and Zhang Linxiu, who are recommended by the Committee of the Fund, are the IIASA Scientific Advisory Committee and national assessment experts. They have participated in IIASA joint conferences and international assessments. NSFC has played an increasingly important role in international stage with GRC, A-HORCs, ASIAHORCs and so on. On May 2017, President Yang Wei was elected as GRC councilor.

6. Serve the overall situation of the country and comprehensively strengthen scientific and technological cooperation with Hong Kong, Macao, and Taiwan

In terms of cooperation with Research Grant Council (RGC) in Hong Kong, the two funding agencies funded 21 projects, with direct funding of 17.63 million yuan, and an average funding intensity of 850,000 yuan per project. At the same time, NSFC-RGC Youth Scholars Forum was continuously promoted to establish a communication and exchange platform to an effective exchange of young people between the two places. The Symposium on the Theory and Practice of Smart Cities organized jointly with the Chinese University of Hong Kong and the Beijing-Hong Kong Academic Exchange Center was well received. In the cooperation with Macao, NSFC and the FDCT jointly funded 21 projects for cooperative research projects, with direct funding of 15.94 million yuan, and an average funding intensity of 2 million yuan per project. At the same time, they sent management personnel with the Macao Science and Technology Development Fund to exchange visits and learn from each other's management experience. In cooperation with Taiwan, NSFC and the K. T. Lee Science and Technology Development Fund jointly funded seven cooperative research projects, with direct funding of 11.664 million yuan and an average funding strength of 1.7 million yuan per project. At the same time, it will maintain close communication and exchanges with Taiwan's cooperative agencies. K. T. Lee Foundation's Secretary-General Wan Qichao led a delegation to participate in the cross-Strait academic exchange activities supported by the two parties three times, which enhanced mutual trust and understanding between the two sides and reached consensus on further promoting cross-Strait scientific and technological cooperation and exchanges.

7. Steadily promote the work of Sino-German Science Center and make new progress in strategic transformation

Sino-German Center for Research Promotion is an important platform for scientific cooperation between China and Germany. In 2017, NSFC continued to uphold the basic principles of mutual respect, mutual benefit and equal cooperation. In accordance with the requirements and resolutions of the Joint Commission, we completed the annual funding and other work of the Sino-German Science Center. In project funding, 107 applications for various types of projects were accepted, 57 were approved for funding, including 7 cooperation projects, 31 academic conferences, 3 short-term workshops, 11 personnel visits, and 4 cooperative research teams. It continues to organize, select and fund 30 outstanding Chinese doctoral students to participate in the Lindau Nobel Prize Laureates Meeting. In terms of improving management, the strategic transformation of the Sino-German Center has made good progress. The two sides agreed on the future positioning of China and the adjustment of the project funding system. At the same time, the internal management work was further regulated. In addition, the two parties jointly organized the 12th session of the Joint Committee to lay a solid foundation for the future development of the Sino-German Center.

Part VII

Research Integrity and Audit Work

NSFC's research integrity and audit activities in 2017 fully implemented the spirits of the 18th and the 19th National Congresses of Chinese Communist Party and the plenary sessions in between, as well as the series of significant addresses by General Secretary Xi Jinping. Led by its party group and guided by the Outline of Innovation-Driven Development Strategy, NSFC prioritized the strategic orientation of "Three Focused Efforts" by improving supervision and management mechanisms, enhancing research integrity governance capacity, carrying out the regulations on NSFC-funded grants management, and strengthening the oversight of awarded grants in light of the overall requirements proposed by the 5th Plenary Session of the 7th NSFC General Assembly on intensifying research integrity.

1. Safeguard research integrity and jointly promote the construction of national research integrity system

Firstly, conduct serious investigation of research misconducts in active response to the mass retraction event. In 2007, NSFC accepted a total of 300 allegations, complaints, self-inspection cases and special cases, a year-on-year increase by 47.8%. The 4th Supervision Committee of NSFC held its 10th, 11th, 12th and 13th plenary sessions consecutively and deliberated on 105 cases. Altogether, 165 respondents were penalized throughout the year of 2017, with 103 respondents being debarred from applying for NSFC grant for a period of 1-7 years and 76 awards withdrawn. Besides, 3 institutions were given an internal notice of reprimand or oral reminder.

In April, 2017 the international journal *Tumor Biology* retracted 107 research papers by Chinese authors. NSFC responded actively by checking the pertinence of the retracted

Figure 1. The 13th Plenary Session of the 4th Supervision Committee of NSFC held in Beijing on September 7, 2018.

papers to NSFC applications or awards in due time and promptly conducting concentrated investigation of 32 relevant papers. Adjudicated by NSFC Supervision Committee, 51 applications were terminated for review, 50 awards were withdrawn, and 82 respondents were penalized. As a member unit, NSFC shared its experience and practice accumulated over the years of handling research misconduct cases and set up the joint investigation team with other member units under the Joint Meeting on Research Integrity Construction mechanism, playing a significant role in formulating the work plan and procedure rules for unified, accountable and stratified handling and investigation of fraudulent papers.

Secondly, intensify supervision and restriction by gradually normalizing proactive supervision mechanism. (1) Follow through on on-site supervision of panel review meetings. Thirty-four supervision teams (68 person-times) were sent out to conduct on-site supervision of 231 panel review meetings in 2017. During the whole-process supervision of panel review meetings, the supervision teams not only organized 3,208 panel reviewers to sign the letter of commitment and assess the fairness among themselves, but listened to opinions and suggestions from the science community and received allegations and complaints. On-site supervision helped panel reviewers raise their awareness of self-discipline and played a key role in maintain the accountability of NSFC's review system. (2) Push on with similarity cross-checking to effectively crack down upon duplicated applications, which decreased year by year. In 2017, investigation was conducted on 25 pairs of applications that displayed high similarity in content and the respondents received due punishment.

Thirdly, gear up research integrity education through popularization and interagency cooperation. (1) Under the normalized mechanism of popularization, full advantage of varied working meetings and training workshops was taken to publicize research integrity, raise the awareness of academic self-discipline, and strengthen consciousness of responsibility in the management and use of NSFC funds. Besides, lectures on code of conduct, conflict of interest, and confidentiality were also arranged during the on-site supervision of panel review meetings, requiring all panel reviewers to strictly abide by relevant regulations and properly perform their duties. (2) As one of the deputy leader unit of the National Leading Group on Scientific Ethics and Academic Norms Popularization and Education, NSFC takes an active part in all working meetings, forums and workshops organized by the leading group. In November 2017, NSFC participated in holding the annual Scientific Ethics and Academic Norms Popularization and Education Conference under the theme of Studying and Carrying out the Spirit of the 19th National Congresses of Chinese Communist Party, and organized all universities and research institutions receiving NSFC funds to watch the conference via live video streaming. (3) Take active part in a series of workshops and public lectures held by relevant departments and agencies on scientific ethics and research integrity with an eye to promoting brainstorming and joint popularization and education.

Fourthly, step up institutionalization and informatization of research integrity. In order to standardize proposal writing, ensure authentic and accurate basic information, and stave off

Figure 2. Scientific Ethics and Academic Norms Popularization and Education Conference under the theme of Studying and Carrying out the Spirit of the 19th National Congresses of Chinese Communist Party Held by CAST, MOE, CAS, CASS, CAE, NSFC and Beijing Municipality in Beijing on November 14, 2017.

research misconduct, NSFC revised the Notice on Research Integrity in view of the new features of research integrity construction in recent years and publicize it in NSFC *Guide to Programs* 2018 for the first time.

Through continuously elaborating requirements, optimizing processes, revising specifications, and conducting security testing of the operational environment, NSFC completed on-line operation of the research integrity information management system, fulfilling the informatization and standardization of receiving and handling allegations and complaints of research misconducts. Great efforts were also put in the optimization and extension of annotation, query and statistical functions of NSFC's Internet-Based Science Information System, which dramatically improved the efficiency of funding and management.

2. Strengthen the supervision of awarded funds by random audit

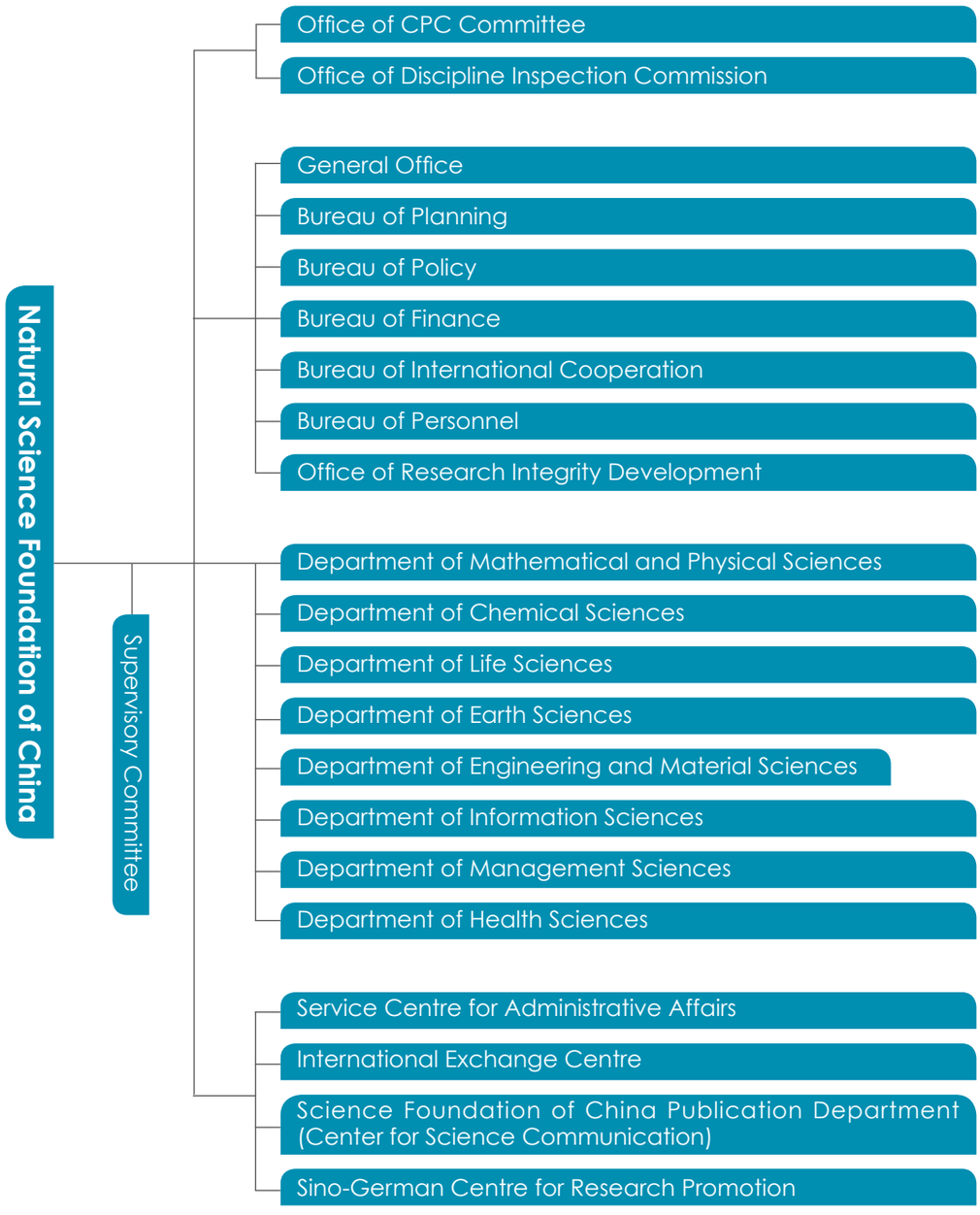
In 2017, NSFC organized the third party audit service to conduct random audit for 399 funded projects from 29 institutions located in Hunan, Anhui and Jiangxi Provinces, covering General Program, Key Program, Major Program, Young Scientists Fund, Excellent Young Scientists Fund, National Science Fund for Distinguished Young Scholars, Science Fund for Creative Research Groups, Fund for Less Developed Regions, and Special Fund for Research on National Major Research Instruments. A total fund of 372 million yuan was audited.

During the audit process, NSFC selected the audit service and arranged site audit in earnest, exchange audit opinions in due time, and analyzed and summarized the problems in the management and use of awarded funds in the round. In line with Regulations of the National Natural Science Foundation of China and Regulations on the Management of Funds Awarded by the National Natural Science Fund, and in light of the CPC Central Committee's spirit of streamlining administration, delegating power and strengthening regulation, and optimizing service, NSFC Council deliberated and passed the working report on the 2017 annual random audit of awarded funds. In active implementation of the NSFC Council's deliberations, audit opinion letters were issued to 29 institutions, requiring rectification of relevant issues, which intensified both the institutions' and PIs' awareness of non-delegable and independent duties in the management and use of funds.

Part VIII

Organizational Structure and Personnel of NSFC

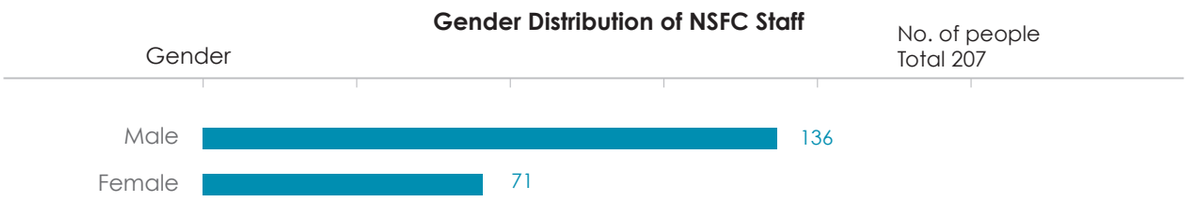
1. Organizational Chart

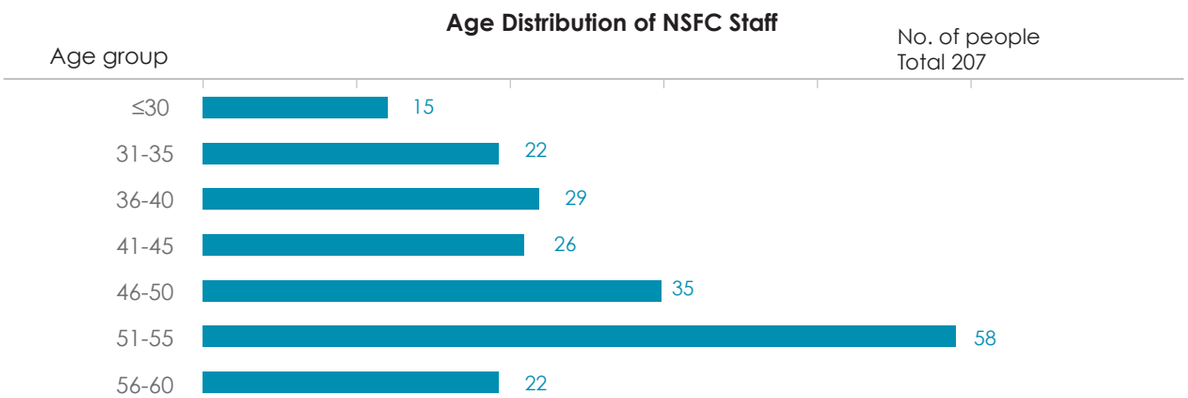


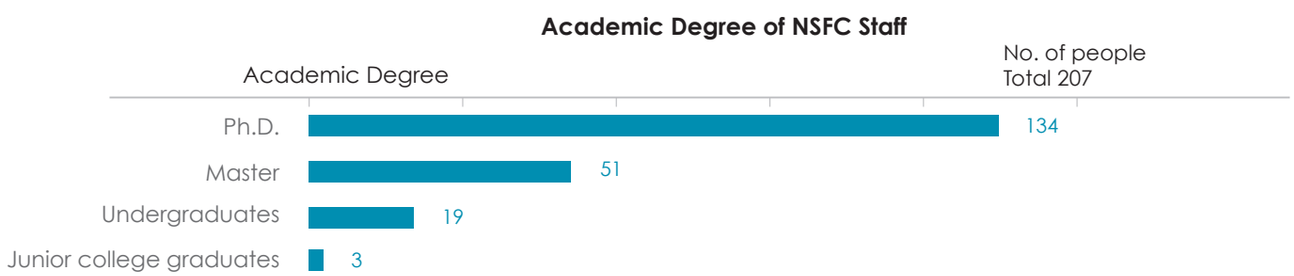
2. NSFC Staff

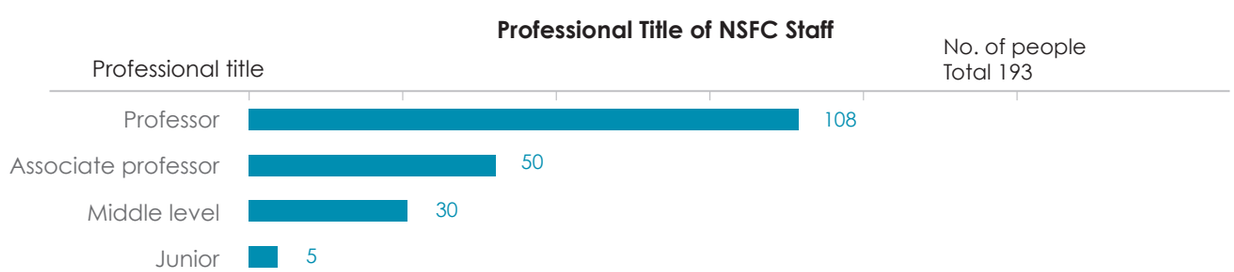
Full time staff

The staff quota of NSFC is 228. By December 31, 2017, NSFC has 207 full time staff, with 136 males and 71 females and 193 with professional and technical titles. The average age is 46.









Rotational program directors in NSFC

By December 31, 2017, there are 83 rotational program directors on duty, and all of them have a Ph.D. degree. Among them, 61 are males and 22 females; 28 are professors or research fellows, 49 are associate professors and 2 have middle level professional titles.

3. Leaders of NSFC's Bureaus, Departments and Subordinate Unit

Leaders of NSFC's Bureaus and Departments

(by December 31, 2017)

Unit	Leaders
General Office	Han Yu, Feng Wenan, Tang Longhua, Zhang Zhaotian (Director of Information Center)
Bureau of Planning	Wang Changrui, Wen Mingzhang
Bureau of Science Policy	Zheng Yonghe
Bureau of Finance	Zheng Zhongwen, Xing Hairu (F)
Bureau of International Cooperation	Feng Feng, Zou Liyao
Bureau of Personnel	Zhou Yanze, Feng Xuelian (F)
Office of Research Integrity Development	Zhu Weitong (F)
Office of Party Committee	Gao Tiyu
Office of Discipline Inspection Commission	Guo Jianquan
Department of Mathematical and Physical Sciences	Xie Xincheng (concurrently), Meng Qingguo, Dong Guoxuan
Department of Chemical Sciences	Zhang Xi (concurrently), Chen Yongjun, Yang Junlin
Department of Life Sciences	Li Peng (F, concurrently), Du Shengming
Department of Earth Sciences	Fu Bojie (concurrently), Wang Qidong, Guo Jinyi
Department of Engineering and Material Sciences	Wang Guangqian (concurrently), Li Ming, Che Chengwei, Wang Guobiao
Department of Information Sciences	Chai Tianyou (concurrently), Qin Yuwen, Li Jianjun , He Jie
Department of Management Sciences	Wu Qidi (F, concurrently), Gao Ziyou
Department of Health Sciences	Zhang Xuemin (F, concurrently), Sun Ruijuan (F), Xu Yanying (F)

Leaders of NSFC's Subordinate Unit

(by December 31, 2017)

Unit	Leaders
Service Centre for Administrative Affairs	Zhang Xiangping (F), Yang Tao, Shi Xinghe, Yuan Youxin
International Exchange Centre	Shi Xinghe (concurrently)
Science Foundation of China Publication Department (Center for Science Communication)	Han Zhiyong, Yang Xinquan
Sino-German Centre for Research Promotion	Fan Yingjie (F, concurrently)

Appendix I

NSFC Major Events in 2017

January 2017

Jan. 9 President Yang Wei attended the State Scientific and Technological Awards Ceremony of 2016.

Jan. 22 The 2017 Meeting on Building Integrity and Combating Corruption was held. Yang Wei, Secretary of the NSFC CPC Committee and NSFC President, chaired the meeting. Wang Yibin, Director of the CCDI Discipline Inspection Group to MOST, attended the meeting.

February

Feb. 13 The feedback meeting of the special inspection of the NSFC CPC Committee by the 8th Central Inspection Team was held in Beijing. Yang Wei, Secretary of the NSFC CPC Committee and NSFC President, chaired the meeting. Ning Yanling, Director of the 8th Central Inspection Team, passed on the inspection feedback. Xia Lizhong, Deputy Director-General of the Office of the Central Leading Group for Inspection Work made requests on rectification work based on inspection feedback.

Feb. 23 President Yang Wei attended the meeting of the Leading Group for the Science and Technology System Reform and Building of a National Innovation System.

March 2017

Mar. 1 The NSFC-State Grid Joint Fund for Smart Grid Research was jointly set up by NSFC and the State Grid Corporation of China. President Yang Wei attended the signing ceremony. Vice President Gao Ruiping signed on the Joint Fund Agreement on behalf of NSFC.

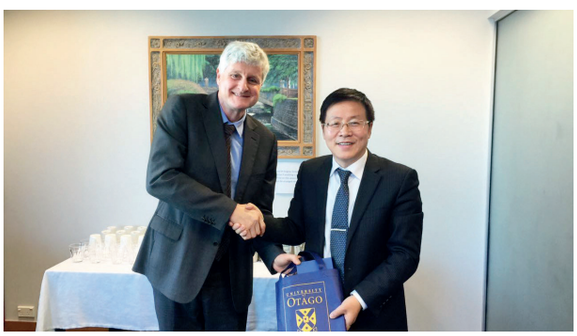
Mar. 15 The meeting to convey the essence of the 5th Session of the 12th CPPCC National Committee and the 5th Session of the 12th National Peoples' Congress was held. President Yang Wei chaired the meeting. Vice President Shen Yan and Yao Jiannian conveyed the essence of the 5th Session of the 12th National Peoples' Congress and Vice President Gao Wen conveyed the essence of the 5th Session of the 12th CPPCC National Committee.

Mar. 17 President Yang Wei, Vice President Shen Yan and Gao Ruiping paid an inspection visit to the receiving site for applications of 2017.

March 2017

Mar. 21 Vice President He Minghong attended the 3rd Meeting of China-Israel Joint Committee on Innovation Cooperation co-chaired by Vice Premier Liu Yandong and Prime Minister Netanyahu of Israel. He signed on the Joint Research Program (2018-2021) between National Natural Science Foundation of China and Israel Science Foundation with Professor Benjamin Geiger, Chairman of the Academic Board of Israel Science Foundation.

Mar. 24 Vice President He Minghong attended the 5th meeting of the Joint Meeting on Promoting Scientific Integrity. The revised Constitution of the Joint Meeting on Promoting Scientific Integrity and the Work Report of the Joint Meeting on Promoting Scientific Integrity were approved at the meeting.



Mar. 27 Vice President Liu Congqiang and Dr. Lester Levy, Chair of the Health Research Council of New Zealand, signed the Arrangement between National Natural Science Foundation of China and Health Research Council of New Zealand on Scientific Cooperation.

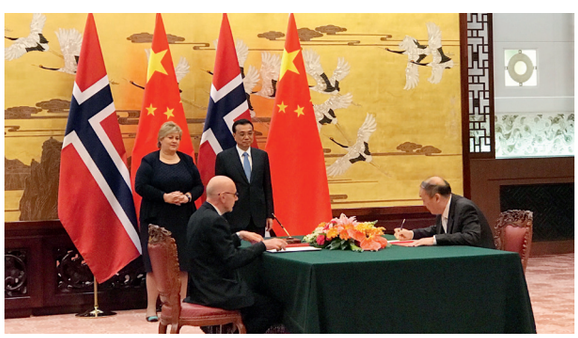
2017

March

Mar. 28 The 5th Plenary Session of the 7th NSFC General Assembly was held in Beijing. The meeting deliberated and approved the work report titled Boosting Basic Research, Promoting Innovation-driven Development and Making New Contribution to Building China into a Strong Science Power in the World delivered by President Yang Wei, the report titled Safeguarding Scientific Integrity, Punishing Scientific Misconduct and Continuing to Advance the Supervision of National Natural Science Fund delivered by President Chen Yiyu of the NSFC Supervision Committee and the Report on the 2017 Budget and Funding Schemes of the National Natural Science Fund and the Implementation of the 2016 Budget and Funding Schemes submitted in writing. The Plenary Meeting was also debriefed by Vice President Gao Wen on the revision of Constitution of the National Natural Science Foundation of China and approved the revised NSFC Constitution.

April

Apr. 5 NSFC held the meeting for newly appointed staff members to take a public oath of allegiance to the Constitution.



Apr. 7 President Yang Wei and Mr. Svein Ole Sæther, Norwegian Ambassador to China, signed the Memorandum of Understanding on Collaboration between the National Natural Science Foundation of China and the Research Council of Norway under the witness of Premier Li Keqiang and the visiting Norwegian Prime Minister Erna Solberg.

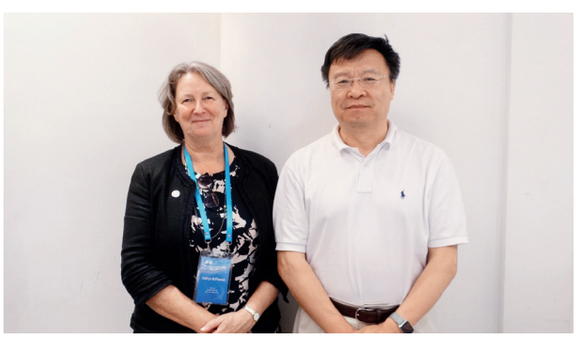
May 2017

May 2 President Yang Wei met with Ms. Liu Yaming, Administrator of China Meteorological Administration. Vice President Gao Ruiping attended the meeting. The two sides made an in-depth discussion on measures to further exert the role of the National Natural Science Fund in fostering scientific and innovation talents and supporting basic research on key scientific problems in meteorological science.

May 9 President Yang Wei chaired the 5th NSFC Executive Committee Meeting in 2017. The meeting deliberated and approved the Funding Schemes of the National Natural Science Fund in 2017.

May 9 Vice President Gao Wen attended the 25th meeting of the Leading Group for National Educational System Reform.

May 14–21 An NSFC delegation led by Vice President Liu Congqiang visited the Royal Society of Edinburgh, University of Glasgow, Swiss National Science Foundation and Swiss Federal Institute of Technology Zurich. Vice President Liu Congqiang was admitted as a Corresponding Fellow of the Royal Society of Edinburgh.



May 18–19 The first China-New Zealand Workshop on Non-communicable Diseases jointly funded by NSFC and the Health Research Council of New Zealand was held in Beijing. Vice President Gao Wen attended the meeting and met with Dr. Kathryn McPherson, Chief Executive of the Health Research Council of New Zealand.

May 20–Jun. 1 President Yang Wei attended the 2017 Annual Meeting of the Global Research Council (GRC) held in Canada and was elected to the GRC Governing Board.

2017

May

May 23 NSFC and the Chinese Academy of Sciences (CAS) set up the NSFC-CAS Joint Fund for Space and Satellite Science. President Yang Wei and CAS President Bai Chunli attended the signing ceremony and delivered remarks. Vice President Gao Ruiping signed on the Joint Fund Agreement on behalf of NSFC.

June

Jun. 5 Vice President He Minghong attended the 6th meeting of the Joint Meeting on Promoting Scientific Integrity. The meeting discussed the retraction of multiple articles by Chinese authors by Tumor Biology and required related organizations to conduct a thorough investigation and make rigorous punishment, adopt a "zero tolerance" policy against misconduct, completely eradicate falsification and fabrication in academic papers and firmly curb academic misconduct.

Jun. 5–14 A delegation led by President Yang Wei visited Italy, France and Greece. During the visit, President Yang Wei met with President of National Research Council of Italy, Deputy Director of the Food and Agriculture Organization, President of the National Agency for Research of France, Alternate Minister of Education, Research and Religious Affairs of Greece and President of the National Hellenic Research Foundation.

June 2017

Jun. 14 Vice President Gao Ruiping attended the summary meeting of the submission of 2017 National Natural Science Fund applications and delivered remarks. Administrative staff from leading institutions of the 36 regional networks nationwide and selected host institutions attended the meeting.

Jun. 14–18 President Yang Wei visited the United States and received an honorary doctor degree from Northwestern University.

Jun. 22 The 2017 awards ceremony for outstanding PhD students selected to attend the Lindau Nobel Laureate Meeting was held at the Sino-German Center for Research Promotion. Vice President Liu Congqiang attended the ceremony and delivered remarks.

Jun. 29 Yang Wei, Secretary of the NSFC CPC Committee and NSFC President, chaired a meeting focusing on the review work of the National Science Fund for Distinguished Young Scholars. Wang Yibin, Director of the CCDI Discipline Inspection Group to MOST and Member of the MOST CPC Committee, attended the meeting and had a discussion with applicants of the National Science Fund for Distinguished Young Scholars.

July 2017

Jul. 2–4 The International Symposium on Funding Science and People Cooperation for a Prosperous Belt and Road hosted by NSFC was held in Beijing. Over 90 delegates from more than 30 science funding agencies and international organizations from countries and regions along the Belt and Road participated in the symposium. President Yang Wei, Vice President Liu Congqiang attended the symposium.

Jul. 3 President Yang Wei met with Professor Nosratollah Zargham, President of the Iranian National Science Foundation (INSF), Professor Damdin Enkhjargal, President of Mongolian Foundation for Science and Technology (MFST), Dr. Manana Mikaberidze, Acting Director General of the Shota Rustaveli National Science Foundation of Georgia (SRNSF), and Professor Sergey Gaponenko, President of Belarusian Republican Foundation for Fundamental Research (BRFFR). President Yang Wei signed the Memorandum of Understanding between NSFC and INSF on Cooperation, the Memorandum of Understanding between NSFC and MFST on Cooperation, the Memorandum of Understanding between NSFC and SRNSF on Scientific Cooperation, the Annex to the Agreement on Cooperation between NSFC and BRFFR during the meetings.

July 2017

Jul. 23–25 The 2017 Expert Committee Meeting for the Special Fund for Research on National Major Research Instruments (via departmental recommendation) was held in Beijing. Five projects entered the final stage of evaluation which included site visit and budget review. President Yang Wei attended the meeting and delivered remarks.

Jul. 28 A study meeting of the Central Group of the NSFC CPC Committee (enlarged session) was held. Members of the NSFC CPC Committee and heads of NSFC departments and bureaus had a group study of national security and secret protection policy. Tian Jing, Director-General of the National Administration for the Protection of State Secrets, gave a lecture. Yang Wei, Secretary of NSFC CPC Committee and NSFC President, chaired the meeting.

August

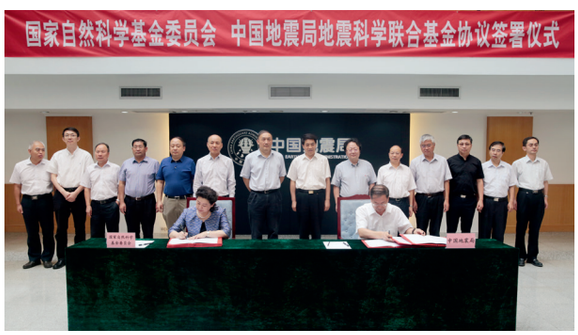
Aug. 1 The 12th Plenary Session of the 4th Supervision Committee of NSFC was held. The meeting deliberated the investigation report by Office of Supervision Committee on the retraction of articles by Chinese authors by Tumor Biology and decided to give rigorous punishment to authors involved. Chen Yiyu, President of the Supervision Committee chaired the meeting. Vice President He Minghong attended the meeting.

Aug. 15 The 9th NSFC Executive Committee Meeting chaired by President Yang Wei approved the projects to be funded by the National Natural Science Fund in 2017.

2017 July

Aug. 24 President Yang Wei and Vice President Gao Ruiping attended the press conference held by the State Council Information Office and introduced the application, evaluation and funding of National Natural Science Fund projects in 2017.

Aug. 29–31 The 2017 panel review meeting for the NSFC-Shanxi Joint Fund for Coal-Based Low-Carbon Technology, the NSFC-Zhejiang Joint Fund for the Integration of Industrialization and Informatization and the NSFC-Liaoning Joint Fund was held. Vice President Gao Ruiping attended the meeting and delivered remarks.



September

Sep. 4 NSFC and the China Earthquake Administration (CEA) set up the NSFC-CEA Joint Fund for Earthquake Science. President Yang Wei attended the signing ceremony and delivered remarks. Vice President Gao Ruiping signed on the Joint Fund Agreement on behalf of NSFC.

Sep. 6 A group study meeting to learn from the late geophysicist Huang Da-nian was held and colleagues and students of Professor Huang Danian were invited to give a lecture on the advanced deeds of Huang Danian to NSFC staff. President Yang Wei chaired the meeting and delivered remarks.

Sep. 12–14 The 2017 panel review meeting for the Joint Fund to Promote Cross-Straits Scientific and Technological Cooperation, the NSFC-Henan Joint Fund and the NSFC-Xinjiang Joint Fund was held. President Yang Wei and Vice President Gao Ruiping attended the meeting.

September 2017

Sep. 18 President Yang Wei attended the opening ceremony of the 6th World Tribology Congress and delivered remarks.

Sep. 19–23 The first Underwater Robot Picking Contest was held by NSFC. Sixteen teams from University of Tokushima, Peking University, Institute of Automation of Chinese Academy of Sciences and other research institutes participated in the contest. Vice President Gao Wen attended the opening ceremony and delivered remarks.

Sep. 22 The 2017 Review Committee Meeting for the National Science Fund for Distinguished Young Scholars was held by NSFC. President Yang Wei attended the meeting and made remarks. Vice President Gao Ruiping chaired the meeting.

Sep. 23–27 Vice President He Minghong attended the InnoTech Expo 2017 and the Hong Kong Innovation and Technology Forum. He also delivered remarks at the Ceremony for the 68th Anniversary of the People's Republic of China by the Higher Education Sector of Hong Kong.

2017

September

Sep. 26 Vice President Gao Ruiping attended the 2017 review meeting for the NSFC-Yalong River Hydropower Development Company Joint Fund.

Sep. 26 The China-UK Life Science and Medicine Summit jointly sponsored by NSFC, Consortium of CAST Life Science Societies, Chinese Academy of Medical Sciences, Royal Society and Welcome Trust was held in Beijing. President Yang Wei attended the Summit and made a keynote speech titled Research Landscape in China: from Revival to International Cooperation.

Sep. 29 NSFC and China National Nuclear Corporation set up the NSFC-CNNC Joint Fund for Nuclear Technology Innovation. President Yang Wei attended the signing ceremony and delivered remarks. Vice President Gao Ruiping signed on the Joint Fund Agreement on behalf of NSFC.

October

Oct. 12 A team led by Vice President He Minghong visited the Exhibition of Achievements of Poverty Alleviation Work in Specific Areas by State Organs.

Oct. 17–19 The 2017 panel review meeting for the NSFC-Shenzhen Robotics Research Center Project, the Joint Fund for the Innovation and Development of China Automobile Industry and Joint Fund for Smart Grid was held. Vice President Gao Ruiping attended the meeting and made remarks.

Oct. 18–24 President Yang Wei attended the 19th National Congress of the Communist Party of China. Vice President Yao Jiannian was invited to sit in on the opening and closing sessions.

October 2017

Oct. 25 NSFC held the first Staff Forum on Innovation. President Yang Wei attended the opening ceremony and delivered remarks. Vice President Gao Ruiping chaired the forum.

Oct. 26 NSFC held a meeting of all staff members in which President Yang Wei, delegate to the 19th CPC National Congress and Secretary of the NSFC CPC Committee, conveyed the essence of the 19th CPC National Congress and made requests on the learning and implementation of the essence of the National Congress and the first plenary session of the 19th CPC Central Committee. Vice President Gao Ruiping chaired the meeting.

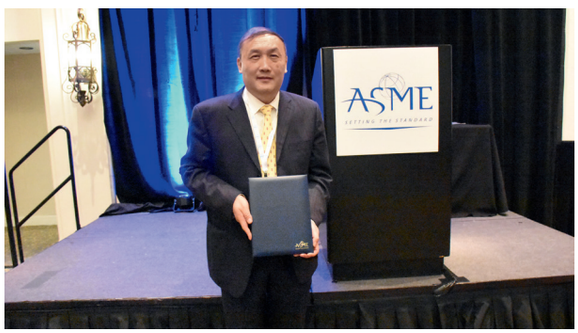
Oct. 26–27 The 2017 appraisal meeting for Science Fund for Creative Research Groups was held. President Yang Wei and Vice President Gao Ruiping attended the meeting.

November

Nov. 3 Vice President Liu Congqiang attended the Ceremony for the 10th Anniversary of the Japan Society for the Promotion of Science Beijing Office.

November 2017

Nov. 5–6 Entrusted by the Organization Department of the Central Committee of the CPC, NSFC held the 2017 interview meeting for “Thousand Talent Program for Young Scholars”. President Yang Wei and Vice President Gao Ruiping attended the meeting and made remarks.



Nov. 6–9 President Yang Wei attended the International Mechanical Engineering Congress and Exposition and was awarded the 2017 Warner T. Koiter Medal by the American Society of Mechanical Engineers.

Nov. 8–10 The 2017 panel review meeting for the NSFC-Yunnan Joint Fund, the NSFC-Shandong Joint Fund and NSFC-Guangdong Joint Fund was held. Vice President Gao Ruiping attended the meeting and made remarks.

Nov. 8 The signing ceremony for the 3rd phase of the NSFC-Yunnan Joint Fund set up by NSFC and People’s Government of Yunnan Province was held in Kunming. Vice President Gao Ruiping signed on the Joint Fund Agreement on behalf of NSFC.

Nov. 20–23 Vice President Liu Congqiang attended the opening ceremony for the China-UK Workshop on Antimicrobial Resistance sponsored by NSFC and Research Councils UK and organized by Renji Hospital of the Shanghai Jiao Tong University School of Medicine.

November 2017 December

Nov. 25–26 NSFC held the 2017 China Intelligent Vehicle Future Challenge Contest. Twenty-nine teams from universities, research institutions and enterprises participated in the contest. President Yang Wei and Vice President Gao Wen attended the awarding ceremony and opening ceremony respectively.

Dec. 1 Vice President Yao Jiannian attended the 16th National Congress of the Chinese Peasants and Workers Democratic Party (CPWDP) and was elected the Vice Chairman of the Standing Committee of the CPWDP Central Committee for the 3rd time.

Dec. 4 President Yang Wei met with Professor Tan Tieniu, Deputy Director of the Liaison Office of the Central People's Government in the Hong Kong S.A.R. The two sides had an in-depth discussion on the implementation of the essence of the 19th CPC National Congress and measures to support the integration between Hong Kong and the inland, promote S&T development in Hong Kong and strengthen S&T exchange and cooperation between Hong Kong and the mainland.

Dec. 12 The 2017 meeting of the management of National Natural Science Fund was held in Beijing. President Yang Wei and Vice President Gao Ruiping attended the meeting and made remarks.

Dec. 14–15 NSFC held the 2017 appraisal meeting for Major Research Plan Projects. President Yang Wei attended the meeting. Vice President Gao Ruiping made remarks at the opening ceremony.

Dec. 21 The meeting between the CCDI Discipline Inspection Group to MOST and NSFC CPC Committee on implementation of the essence of the 19th CPC National Congress and rigorous enforcement of party rules was held. Wang Yibin, Director of the CCDI Discipline Inspection Group to MOST, passed along the suggestions of CCDI Discipline Inspection Group to MOST on promoting the essence of the 19th CPC National Congress and further carrying forward the comprehensive and rigorous enforcement of party rules at NSFC. Yang Wei, Secretary of the NSFC CPC Committee and NSFC President, chaired the meeting and delivered remarks.

Appendix II

Shuangqing Forum

Shuangqing Forum is a high-level strategic and academic exchange platform sponsored by NSFC to create favorable academic environment, promote interdisciplinary integration, develop innovation culture, and serve the development of basic research. Based on science fund management, Shuangqing Forum mainly concentrates on highly cross-disciplinary frontier issues, major basic scientific issues related to the demand of the national strategy, and major management and policy issues in improving the science funding system.

In line with the principle of letting a hundred flowers blossom and a hundred schools of thought contend, Shuangqing Forum strives to create a sound environment for the pursuit of truth and fair competition, advance constructive academic critics and ensure that participants can fully enjoy the exchange of thoughts and ideas. Compared with general academic workshops, the Forum has four features: (1) Interdisciplinary contents. Each forum is jointly organized by more than two departments and the topic of each forum is multidisciplinary. (2) Effective results. The results are highly relevant and good-oriented, because the themes of the forums are closely related to the national natural science fund and its management. (3) Innovative organizing forms. The fundamental task of the forum is to explore new ways for academic exchange so as to inspire innovative ideas. (4) Standardization. The forums have clear positioning and standard organizing procedures.

In 2017, Shuangqing Forum sponsored 22 sessions (from the 174th to 195th session). The total number of participants reached 1,173, among which over 70 participants were members of CAS and CAE. NSFC's science departments were responsible for 20 sessions, and administration bureaus held 2 sessions. The themes of 10 sessions were related to frontier basic scientific issues, 9 sessions focused on deep-level scientific issues addressing the demand of the national development strategy, and 3 sessions were related to major policy and management issues in the development and improvement of science funding system.

Shuangqing Forum not only provided a platform for the exchange and cooperation among researchers from different disciplines, promoted the exchange of academic ideas and the expansion of academic vision, but also helped the fund managers to learn about the frontier scientific issues and carry out strategy research, thus enriching the dialogue mechanism between managers and scientists. The forum focuses on the consensus reached between the scientific community and other sectors, and the results generated from the forums are fully reflected in the national natural science funding and management. For example, the topics discussed in the 110th session—*Theoretical and experimental study of fine flow*, the 158th session—The Silk Road and Energy Resources—Study on Tethys Earth Power System, and the 64th session—*Dynamic modification and chemical intervention of biological macromolecules* were key scientific issues related to the Major Research Plan in 2017; the topics discussed in the 139th session—*The efficient water use in agriculture in arid area and its ecological and environmental*

effect, the 140th session—*Internet finance and the management of its service operation,* the 144th session—*The micro ecology and human health,* the 160th session—*The Basic Scientific Issues Related to Key Aerodynamic Thermodynamics of High—speed Rotating Compression System,* and the 161th session—*Major Theoretical and Practical issues of Accounting, Auditing and Corporate Finance* were listed as priority area in the funding direction of Major Project.

In 2017, Shuangqing Forum mainly focused on three priorities: first, rapid response to the scientific issues related to the national major demands, for which three sessions were organized under the themes of Science and Technology Support and Corps Southward Development - Vision and Action, Key scientific issues in the design and construction of large-scale wind tunnels, and The National Strategic Needs of Preventive Medicine Development and Its Key Frontier Basic Scientific Issues; second, promotion or expansion of the national science funding in light of major scientific or management issues of social concern, for which three sessions were organized under the themes of Research Frontier and Progress of Synthetic Biology, Basic theory and application of the Artificial intelligence, and Connecting the Future: Education, Technology and Innovation; third, to further give play to the orientation role of the Shuangqing Forum, the Bureau of Policy and The Center for Scientific Communication set up the Shuangqing Forum column on the NSFC website to introduce each session in an all-round way. In the meantime, a number of academic reviews based on discussions in the Forums were published in publications such as China Science Foundation, Basic Research in China and Discipline Policy Dynamics, 11 of which were published on the China Science Foundation in 2017.

Topics of Shuangqing Forum in 2017

The 174th Session: Study on Symmetry and Breaking Mechanism in Basic Interaction
(March 31 to April 1, 2017, Beijing)

The 175th Session: Theories and Practices of Marketing in the Background of Economic Transformation
(May 4-5, 2017, Wuhan)

The 176th Session: Discussion on Funding Approaches to International Research Center for Basic Science
(May 4-5, 2017, Beijing)

The 177th Session: Key Scientific Issues of Prevention and Treatment of Metabolic Diseases by Integrated Traditional Chinese and Western Medicine
(May 11-12, 2017, Beijing)

The 178th Session: Key Basic Scientific Issues of Bio-Manufacturing
(May 10-11, 2017, Hangzhou)

The 179th Session: Theories and Methods of Integrated Urban Transport System Management Oriented by New Urbanization
(May 22-23, 2017, Beijing)

The 180th Session: Opportunities and Challenges of Ocean Optics
(June 2-3, 2017, Hangzhou)

The 181st Session: Creation of Scientific Instruments from the Perspective of Theoretical Chemists
(June 11-13, 2017, Dalian)

The 182nd Session: Science and Technology Support and Corps Southward Development —Vision and Action
(June 11-12, 2017, Urumchi)

The 183rd Session: Iron Glass and its Properties
(July 22-23, 2017, Xi'an)

The 184th Session: Ionic Liquids: Molecular Chemistry Engineering and Green Process Innovation
(July 27-28, 2017, Beijing)

The 185th Session: Key Scientific Issues in the Design and Construction of Large Scale Wind Tunnels
(August 1-2, 2017, Mianyang)

The 186th Session: Connecting the Future: Education, Technology and Innovation
(September 18-19, 2017, Hangzhou)

The 187th Session: Theory, Methods and Applications of Neuromanagement
(September 7-8, 2017, Hangzhou)

The 188th Session: Chemistry: Opportunities Beyond the Mainstream
(September 20-21, 2017, Beijing)

The 189th Session: Two-Dimensional Soft Material Hybrid Functional Materials
(September 27-28, 2017, Chengdu)

The 190th Session: Key Theories and Techniques for Creating Animal Germplasm
(October 19-20, 2017, Nanchang)

The 191th Session: The Challenge and Countermeasures of Bacterial Resistance
(October 31 to November 1, 2017, Beijing)
The192th Session: The National Strategic Needs of Preventive Medicine Development and Its Key Frontier Basic Scientific Issues
(October 20-21, 2017, Beijing)

The 193th Session: Research Frontier and Progress of Synthetic Biology
(October 3 to November 1, Shanghai)

The 194th Session: The Basic Theory and Application of Artificial Intelligence
(December 2-3, 2017, Changsha)

The 195th Session: The International Frontier of Marine Geology and Geophysics in the New Era and the Development Strategy and Breakthrough Direction in China
(December 7-8, 2017, Guangzhou)

Figure 1. Connecting the Future: Education, Technology and Innovation (the 186th Session).

Figure 2. The International Frontier of Marine Geology and Geophysics in the New Era and the Development Strategy and Breakthrough Direction in China (the 195th Session).