MARS ROVER ZHURONG
Zhurong is China's first Mars rover. On May 22, 2021, the Zhurong rover arrived on the surface of Mars and began its exploration. As of May 5, the Zhurong rover had worked for 347 Martian days and has traveled a total of 1,921 meters.

DARK MATTER PARTICLE EXPLORER WUKONG
Wukong is China's first space astronomical satellite. Launched in 2015, it aims to discover and study dark matter, an invisible substance that does not interact with the electromagnetic force yet makes up about 25 percent of the universe.

YUTU 2 LUNAR ROVER
The Yutu 2 lunar rover landed on the far side of the moon on Jan 3, 2019. It is the first lunar rover to set foot on the dark side of the moon. As of Jan 6, the Yutu 2 lunar rover had traveled 1,003.9 meters, and it is still exploring the unknown region.

MICIUS QUANTUM COMMUNICATION SATELLITE
Micius is the world's first space quantum science experimental satellite. Launched in 2016, the satellite has conducted many experiments in basic sciences related to quantum communication and quantum mechanics.

SDGSAT-1
The world's first scientific satellite dedicated to serve the United Nations' 2030 Agenda for Sustainable Development. Launched in 2021, the satellite will provide data support for the evaluation and research of multiple indicators for the sustainable development goals.

TIANGONG SPACE STATION
Tiangong Space Station is a national-level space laboratory assembled in orbit with multiple modules. It is used to carry out large-scale space science and technology experiments that require long-term human participation. The space station is expected to finish construction around 2022.

CHINA TO PROMOTE WIDESPREAD INNOVATION FOCUSED ON SCI-TECH

Country is celebrating remarkable achievements in those fields

China promotes all-encompassing innovation that focuses on science and technology. The country has also planned how to realize high-level scientific and technological self-reliance and self-improvement.

Zhang Yuzhuo, vice-president of the China Association for Science and Technology, wrote these remarks in an article published in the Beijing-based Business Management Journal in late 2021.

Scientific and technological self-reliance and self-improvement embody the country's development practice and logic during the past century, Zhang wrote. The Party has led people to create achievements such as the first atomic and hydrogen bombs and missile and satellite launches in the 1960s and 1970s.

It has implemented strategies of reinvigorating the country through science, education and development that is driven by innovation. These strategies have been engrained in the country since the reform and opening-up policy adopted in 1978.

It further prioritizes innovation on the key place of national development and advocates stimulating creativity in professionals during the new era.

It deepens reform with tenacity, develops systematization of scientific and technological innovation and takes solid steps toward high-level scientific and technological self-reliance and self-improvement.

Chinese scientists have embodied the spirit of patriotism, innovation, dedication, collaboration and education over the past century. The spirit demonstrates the style of high-level scientific and technological self-reliance and self-improvement, Zhang said.

It is necessary to inspire scientific and technological workers to endure hardships, dare them to innovate and help them get rid of imitation. It is also necessary to consolidate the first impetus role of innovation in advancing high-quality development and use inclusiveness of science and technology to achieve common prosperity.

It is necessary to gather strategies, plans and policy resources to support scientific and technological self-reliance and self-improvement. It's also necessary to help companies to innovate by offering them guidance and establishing platforms for them.

The industrial and supply chains are designed to be controllable. Cooperation between enterprises and universities should be furthered to develop safe and reliable innovation chains with strong capacities to deal with emergencies and changes.

Upstream and downstream companies can enjoy closer partnerships in terms of innovation and cooperate to increase their capabilities of coping with risks.

It is necessary to comprehensively enhance the systematization of scientific and technological innovation to guarantee scientific and technological self-reliance and self-improvement.

New relationships among companies, universities and research institutions should be promoted. It is necessary to systematically decide major tasks and also to organize and implement major projects to efficiently utilize professionals, technologies and capital.

It is possible to enhance the efficiency of both scientific research and innovation activities to advance systematization of scientific and technological innovation.

High-level research-type universities can perform their functions as social innovation incubators while national scientific research institutions should highlight their leading role in cutting-edge fields.

Scientifically and technologically leading companies and new-type research and development institutions should be expanded and become the pacesetters in industrial reforms.

Attracting and training innovative professionals is also important for cementing a foundation of scientific and technological self-reliance and self-improvement.

Trust should play a key role in employing professionals while training in capacity for innovation and critical thinking should also be more greatly prioritized.

It is necessary to value both scientific and technological innovation and the popularization of science and promote advocacy of science and innovation in the society, which is an important symbol of social civilization.

A good innovative and creative environment should be provided to attract, gather and train professionals. Doing so will help make China's innovative development attractive and appealing among global professionals.

Open innovation may be a key path to realizing scientific and technological self-reliance and self-improvement.

It is necessary to adapt to the world's development trends of mutual learning and coexistence, while also embracing the concepts of opening-up, trust and cooperation to participate in the establishment of a global innovation system.

It is important to promote China's scientific and technological development to contribute more to the progress of human civilization and make the country's modernization an integral part of the modernization of all mankind.

China's capacity for innovation was further enhanced in 2021, according to a government report. Fields such as manned space flight, Mars exploration and energy engineering made new breakthroughs last year.

The development of national laboratories was enhanced while the implementation of major scientific and technological projects was also promoted last year.

The Chinese government wants to advance scientific and technological innovation, improve industries and depend on innovation to increase development quality this year, the report said.

It will enhance the capacity for scientific and technological innovation in 2022 by continuing to implement a three-year plan (2021-23) for the reform of the scientific and technological systems.

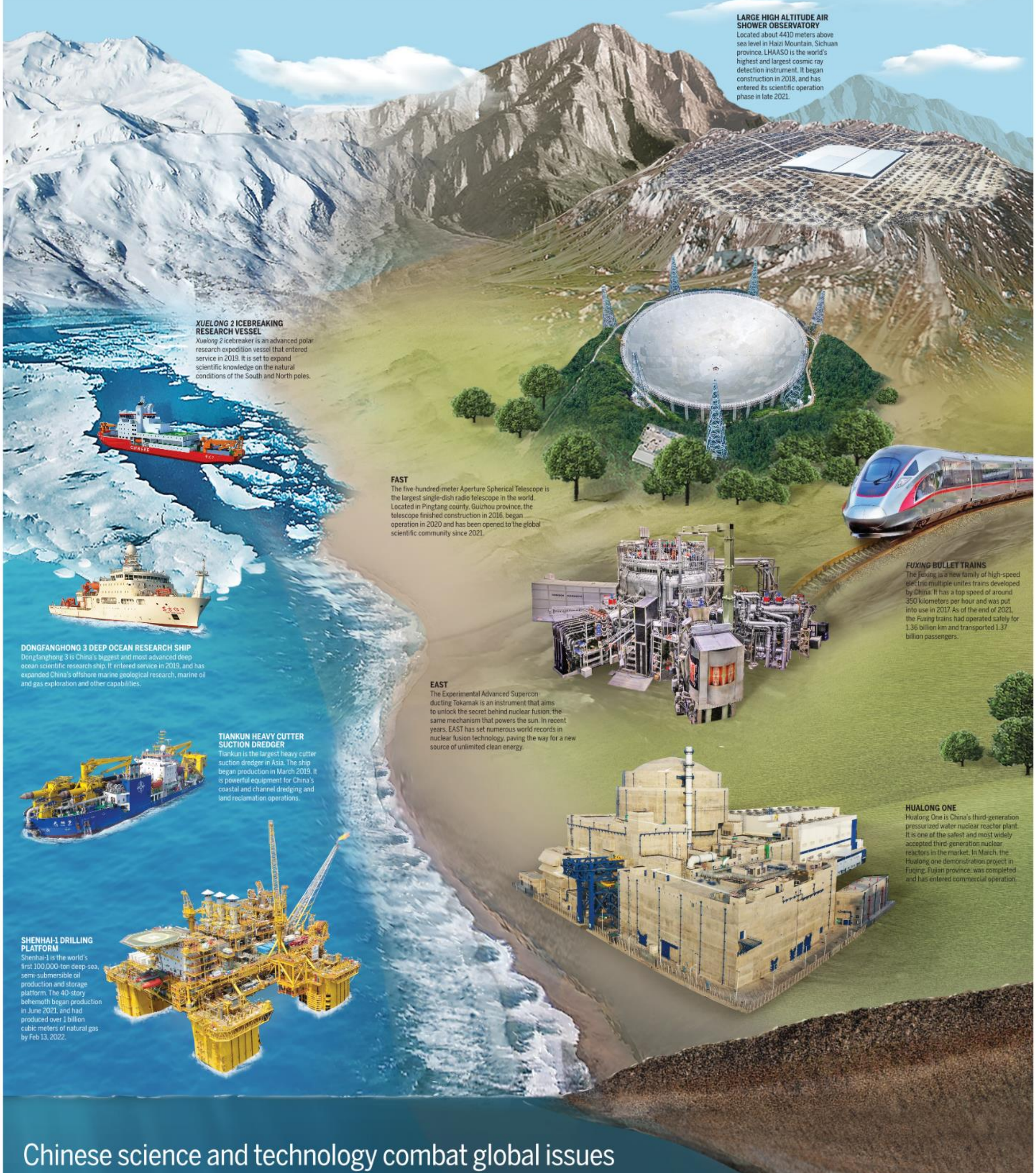
It plans to promote the development of national laboratories and nationally significant labs, help higher learning institutions and scientific research organizations to play their roles and improve management of major scientific and technological projects this year.

It will support different regions in increasing their scientific and technological input, enhancing the popularization of science and promoting international scientific and technological cooperation in 2022.

It aims to advocate scientists' spirit and increase support for young scientific research workers to motivate professionals to concentrate on their studies.

It will keep promoting development of key technologies, further cooperation among companies, universities and research institutes and advance commercialization of scientific and technological achievements. It plans to strengthen the protection and application of intellectual property, promote startups and investment and innovate in scientific and technological finance services.

C919 PASSENGER JET
The C919 is China's first narrow-body airliner. The plane is designed to seat around 160 to 170 passengers, and it made its maiden flight in May 2017.



LARGE HIGH ALTITUDE AIR SHOWER OBSERVATORY
Located about 4410 meters above sea level in Haizi Mountain, Sichuan province, LHAASO is the world's highest and largest cosmic ray detection instrument. It began construction in 2018, and has entered its scientific operation phase in late 2021.

***XUELONG 2* ICEBREAKING RESEARCH VESSEL**
Xuelong 2 icebreaker is an advanced polar research expedition vessel that entered service in 2019. It is set to expand scientific knowledge on the natural conditions of the South and North poles.

FAST
The five-hundred-meter Aperture Spherical Telescope is the largest single-dish radio telescope in the world. Located in Pingtang county, Guizhou province, the telescope finished construction in 2016, began operation in 2020 and has been opened to the global scientific community since 2021.

***FUXING* BULLET TRAINS**
The Fuxing is a new family of high-speed electric multiple unites trains developed by China. It has a top speed of around 350 kilometers per hour and was put into use in 2017. As of the end of 2021, the *Fuxing* trains had operated safely for 1.36 billion km and transported 1.37 billion passengers.

DONGFANGHONG 3 DEEP OCEAN RESEARCH SHIP
Dongfanghong 3 is China's biggest and most advanced deep ocean scientific research ship. It entered service in 2019, and has expanded China's offshore marine geological research, marine oil and gas exploration and other capabilities.

EAST
The Experimental Advanced Superconducting Tokamak is an instrument that aims to unlock the secret behind nuclear fusion, the same mechanism that powers the sun. In recent years, EAST has set numerous world records in nuclear fusion technology, paving the way for a new source of unlimited clean energy.

TIANKUN HEAVY CUTTER SUCTION DREDGER
Tiankun is the largest heavy cutter suction dredger in Asia. The ship began production in March 2019. It is powerful equipment for China's coastal and channel dredging and land reclamation operations.

HUALONG ONE
Hualong One is China's third-generation pressurized water nuclear reactor plant. It is one of the safest and most widely accepted third-generation nuclear reactors in the market. In March, the Hualong one demonstration project in Fuqing, Fujian province, was completed and has entered commercial operation.

SHENHAI-1 DRILLING PLATFORM
Shenhai-1 is the world's first 100,000-ton deep-sea, semi-submersible oil production and storage platform. The 40-story behemoth began production in June 2021, and had produced over 1 billion cubic meters of natural gas by Feb 13, 2022.

Chinese science and technology combat global issues

By Yuan Shenggao

Although China has made notable achievements in scientific research over the years, the Chinese scientific community should further collaborate with their international peers to expand research and innovation capabilities and tackle common challenges amid the current global situation, said senior Chinese officials.

Wan Gang, president of the China Association for Science and Technology, called on the Chinese science community to unite scientists across the globe and bring scientific exchanges and technological cooperation to the forefront, in order to work under the principle of building a community and shared future for mankind.

This will require Chinese scientists to be more collaborative and advocate principles of open science without borders to facilitate new innovations and solutions to the common issues faced by all humankind, Wan said in an article.

At present, the global situation has been fundamentally shaken by particular issues including the COVID-19 pandemic. The new phase of the scientific and technological revolution and industrial reform is now unfolding. At this moment, there is an urgent demand for collaboration among the global community engaged in scientific research, Wan said.

A senior Chinese official once said innovation is the decisive factor in promoting economic and social development and addressing the common challenges of mankind. Such global cooperation can boost higher-level openness and provide systematic solutions to the common concerns of people all over the world.

At present, China has established cooperation relationships in scientific research with more than 160 countries and regions. It is a member of more than 200 international organizations and multilateral frameworks. It has signed up to 115 intergovernmental scientific and technological cooperation agreements.

The China Association for Science and Technology and its regional offices across China have joined 372 international scientific and technological organizations. It has firmly set eyes on some major projects such as the International Thermonuclear Experimental Reactor based in France and paved the way for more cooperation in epidemic prevention and control amid a grim COVID-19 situation.

Some major projects, such as the Five-hundred-meter Aperture Spherical Telescope — the world's largest single dish radio telescope — and the Shanghai Synchrotron Radiation Facility project, were put into service and opened to global visitors.

Since the outbreak of COVID-19, Chinese scientific and technological workers have been actively promoting a shared system to deliver anti-epidemic knowledge and information.

They quickly isolated and identified virus strains and shared the whole genome sequence with the World Health Organization. They carried out frequent information exchanges on scientific journals and initiated close cooperation in virus tracing, clinical diagnosis and treatment, vaccination experiments and testing of infected people.

Those efforts have provided basic information for scientists around the world in their relevant research and helped some developing countries and vulnerable groups get vaccines and medicine at lower costs.

Since the Chinese government announced that it would peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060, China has taken many routes and put in substantial efforts to pursue the goals.

In recent years, technological innovations have played a key role in China's energy field, with new achievements continuously emerging. China's ultra-supercritical coal-fired power generation and ultra-high voltage power transmission technique achieved a world leading level.

Nuclear power projects, such as Hualong One technology — China's domestically developed third-generation reactor — are also a crucial step in this effort.

The utilization scale of renewable energy in China ranked top across the globe. By the end of 2020, the cumulative installed capacity of renewable energy in China accounted for about one-third of the total installed capacity in the world.

Among them, the cumulative installed capacity of hydropower, wind power and photovoltaic power generation all ranked first in the world, providing strong support for the utilization of clean and low-carbon energy.

Accelerating the development of new energy vehicles is also a key path to move towards the goal of carbon neutrality. In 2021, the global market of new energy vehicles maintained rapid growth. The sales volume of new energy vehicles in China has exceeded 3 million for the year.

At the 2021 World New Energy Vehicle Congrass, automobile enterprises from 15 countries established the "Hainan consensus" which advocated the green and low-carbon development of the whole life cycle and the whole industrial chain of new energy vehicles through low-carbon energy supply, low-carbon material supply, low-carbon production process and low-carbon transportation.

While dealing with global climate change, land desertification has also become an increasing concern. As a major force in tackling desertification around the globe, China has adhered to the principle of "ecology and green development are the priority" and made every effort to solve land desertification over the decades.

International collaboration on science and technology is also a significant component of the Belt and Road Initiative which takes cultural exchanges and people's connections across the globe as a main subject, Wan said.

Under the framework of the BRI, China has adhered to the principles of peace and cooperation, openness and inclusiveness, to pursue mutual benefit and win-win results. With full respect for the development targets of BRI countries and regions, China carried out scientific and cultural exchange projects, constructed jointly managed laboratories, set up science and technology industrial parks and guided better commercialization of research results, Wan said.

Under the principle of building a community with a shared future for mankind, China held fast to the global vision and built up its innovation confidence. It worked hand in hand with BRI countries and regions in scientific and cultural cooperation, education, public health, digital economy, green development and other fields, Wan said.

A senior official said: "Science and technology are powerful tools for development and may also be the reason for risks. We should proactively study and judge the conflicts, social risks and ethical challenges brought about by science and technology and improve the laws and regulations, ethical review rules and regulatory framework."

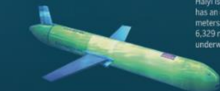
"Moreover, the Chinese science community should deeply participate in global governance, provide valuable Chinese insight and help shape the concept of science and technology for the greater good. In this way science and technology can better promote human well-being and make greater contributions under the principle of building a community of a shared future for mankind."

At present, a new phase of the scientific and technological revolution is taking place. And scientific and technological innovation is profoundly influencing the production and lifestyles of human society, Wan said.

Entering a new stage of development, China is more determined to deepen opening-up and global cooperation in science and technology and advocate the spirit of open science without borders, barriers and discrimination, Wan added.

SHENHAI YONGSHI MANNED SUBMERSIBLE
Shenhai Yongshi (Deep-sea Warrior) is a manned submersible designed to operate around 4,500 meter depths. It entered serve in 2017 and has carried out numerous missions to study ocean resource exploration, geochemistry research and marine biology.

4,500m



HAIYI UNDERWATER GLIDER
Haiyi is a series of underwater gliders that has an operating depth ranging from 300 meters to 7,000 meters. In 2017, Haiyi dove 6,329 meters, setting a new world record for underwater glider diving depth.

7,000m

HAIDOU-1 UNMANNED SUBMERSIBLE
Haidou-1 is an advanced remote-controlled unmanned submersible. On April 23, 2020, it set a national diving record of 10,907 meters in the Mariana Trench.

10,907m

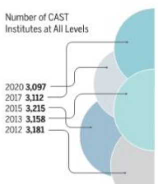
FENDOUZHE MANNED SUBMERSIBLE
Fendouzhe (Striver) is China's new deep-sea manned submersible with full ocean depth capability. On Nov 10, 2020, vehicle set a new national record by diving 10,909 meters in the Mariana Trench. It entered service in March, 2021.

10,909m

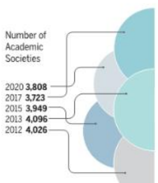
10 years on
精彩十年

ASSOCIATIONS OR ACADEMIC SOCIETIES AND PERSONNEL

Number of CAST Institutes at All Levels



Number of Academic Societies

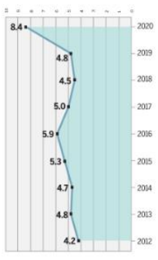


SERVICES FOR THE SCIENTIFIC AND TECHNOLOGICAL WORKERS

147,265
Number of Recognition and Award to S&T Workers in **2020**

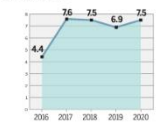
40,131
Number of Recognition and Award to Female S&T Workers in **2020**

Number of Recognition and Award to Young S&T Workers Under the Age of 40 (under the age of 45 in 2018 and later)
Unit: 10,000 persons

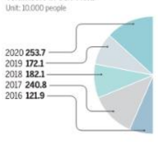


422,000
Number of S&T workers reported by the media in **2020**

Full-time S&T Workers
Unit: 10,000 people

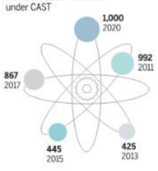


Volunteers in S&T Field
Unit: 10,000 people

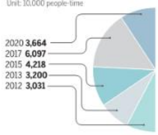


S&T POPULARIZATION ACTIVITIES

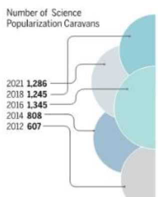
Number of S&T Museums under CAST



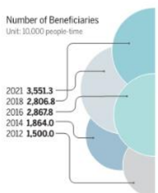
Number of Participants
Unit: 10,000 people-time



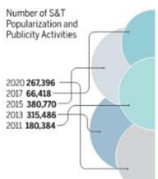
Number of Science Popularization Caravans



Number of Beneficiaries
Unit: 10,000 people-time

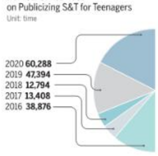


Number of S&T Popularization and Publicity Activities



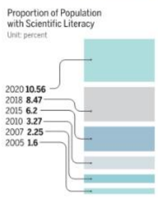
248,734
Participants in **2020**
Unit: 10,000 person-time

Number of Activities on Publicizing S&T for Teenagers
Unit: time



SURVEY ON CHINESE POPULATION'S SCIENTIFIC LITERACY

Proportion of Population with Scientific Literacy
Unit: percent

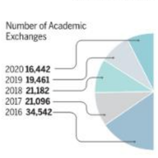


ACADEMIC EXCHANGES

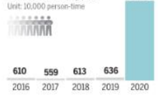
65
Number of pilot cities and parks pioneering their work under the theme of "Innovation China"

130
Number of groups providing service under the framework of "Innovation China"

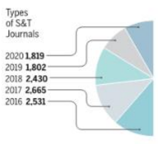
Number of Academic Exchanges



Number of Participants
Unit: 10,000 person-time

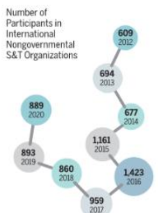


Types of S&T Journals



OPENNESS AND COMMUNICATION ACTIVITY ON TECHNOLOGY

Number of Participants in International Nongovernmental S&T Organizations



2,248
Experts in International Nongovernmental S&T Organizations in **2020**

Source: Statistics Yearbook; The Annual Statistics Report on the Development of CAST

GRPHICS BY MUKESH MOHANAN / CHINA DAILY

Xue Qikun, 59

Resilience, determination, and a strong drive for excellence toward solving a major scientific question are the qualities that transformed Xue Qikun from a poor student from rural Shandong province to one of the country's most accomplished physicists.

In early 2013, after four years of rigorous experiments, Xue and his team published their discovery of the quantum anomalous Hall effect in the journal Science, sending a shockwave through the global physics community.

The journal's reviewers called Xue's discovery a "milestone" and "one of the most awaited phenomena in topological physics". In April 2013, C. N. Yang, who won the Nobel Prize in physics in 1957, called Xue's work "the first Nobelprizeworthy physics paper from a Chinese lab".

The effect can create "highways for electrons" in topological insulators, a class of exotic material that is conductive on the outside but insulating on the inside, without the use of a strong magnetic field.

If used in everyday gadgets, the effect may greatly reduce energy consumption and heat dissipation, allowing engineers to design more compact and powerful electronics and photonics, Xue said.

"Creating new scientific theory and discovering new phenomena and effects are the crown jewels of fundamental research," Xue said. "The discovery of the quantum anomalous Hall effect represents a major contribution by Chinese physicists to humanity's treasure trove of knowledge."

In 2020, Xue left his position as the vice-president of Tsinghua University and brought his teaching philosophy to the Southern University of Science and Technology, where he hopes to continue to cultivate a wealth of world-class scientific talents capable of creating major original breakthroughs in basic research.

Xue said a quality research university should encourage scientific exploration, tolerate failure, uphold academic freedom and enhance basic research.

It should also have an evaluation and support system that is beneficial for nurturing young talents, providing sustained support for basic research, and creating original innovations and breakthroughs, he added.

A world-renowned experimental physicist in condensed matter physics, superconductors and topological insulators. He is an academician of the Chinese Academy of Sciences and a fellow of the American Physical Society.

Xue received the first prize of the 2018 State Natural Science Award for his discovery of the quantum anomalous Hall effect in a lab experiment. He became the first Chinese citizen to win the Fritz London Memorial Prize in 2020. He is currently the president of the Southern University of Science and Technology in Shenzhen, Guangdong province.

Cai Tao, 40

For Cai Tao, an associate researcher with the Tianjin Institute of Industrial Biotechnology at the Chinese Academy of Sciences, blue is not a color associated with sadness, but with hope and success.

For over six years, his team focused on a single task: how to synthesize starch in a way that is similar to the process in plants, but do it much faster.

Unlocking this insight is key to sustainability on Earth and future space exploration as it theoretically allows scientists to recycle carbon dioxide and turn this common industrial byproduct and greenhouse gas into food.

With the aid of supercomputing and clever bioengineering, Cai streamlined the complex natural starch-making process via photosynthesis into 11 steps, with the final product being starch, whose solution turns blue upon contact with iodine.

"On July 24, 2018, our solution turned light blue for the first time after hundreds of failed experiments. It was a great moment of introspection and awe," he said. "We overcame countless difficulties over the years, and for us that light blue in a tube shone like a bright ray of hope."

Cai's findings were published in the journal Science. The Ministry of Science and Technology, the Chinese Academy of Sciences, and the China Union of Life Science Societies at the China Association for Science and Technology unanimously named it one of China's biggest original breakthroughs in basic sciences last year.

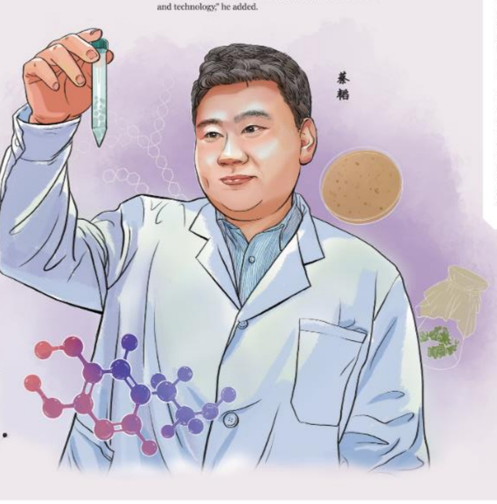
Reflecting on his achievement, Cai said maintaining curiosity, bravely forging a new path, and having the perseverance to push through the rigorous and monotonous work are the key to success for young scientists.

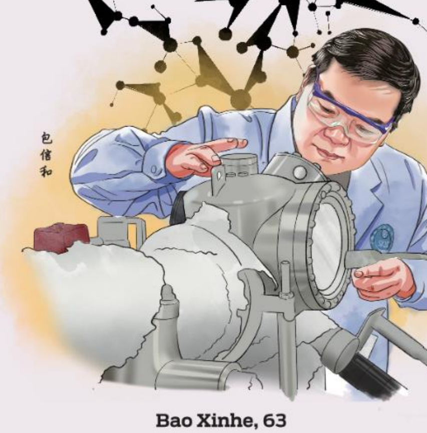
Aligning personal research interest with the major strategic needs of the country and the most challenging scientific questions will generate enormous passion and energy crucial for making original breakthroughs, he said.

"I hope more young scientists, including myself, can keep calm and remain focused on solving the basic scientific challenges behind our country's needs and make our mark on China's path toward achieving self-sufficiency in science and technology," he added.

An associate researcher at the Tianjin Institute of Industrial Biotechnology of the Chinese Academy of Sciences. In 2021, a team consisting of Cai and the institute's director Ma Yanhe became the first in the world to artificially synthesize starch from carbon dioxide in a lab experiment.

The new technique was published in the journal Science and would revolutionize agriculture if proven to be economically viable at the industrial level. The research was named one of China's top 10 scientific advances last year by the High-tech Research and Development Center of the Ministry of Science and Technology.





Bao Xinhe, 63

Passion, communication, unyielding curiosity and a keen eye for detail, along with decades of rigorous hard work, are some of the secrets that led to Bao Xinhe and his team discovering a new type of catalysis that holds promising industrial applications in fields of energy, oil refining, advanced materials and other sectors.

The concept of "nano-confined catalysis" provides important guidance on the design of highly efficient catalysts, which are defined as substances that facilitate chemical reactions without undergoing any permanent chemical changes themselves.

"The key to making efficient chemical reactions with less environmental and energy impact lies in a deep understanding of reaction mechanisms," Bao said.

"However, we don't always know how the reactants are converted into products, and what will come out in the end. It functions like a black box. The nano-confined catalysis concept can shed some light on this, leading to more precise and controllable chemical reactions."

One major application of the nano-confined catalysis concept is the creation of a new type of catalyst that can directly convert carbon monoxide and hydrogen derived from coal gasification into light olefins without using a lot of water and energy, Bao said. This creates a new path to the efficient industrial development of water and energy-saving coal chemicals.

Another application of the concept is a catalyst designed to clean traces of carbon monoxide from hydrogen at room temperature, thus preventing the gas from deactivating the precious metal catalysts found in hydrogen-oxygen fuel cells, Bao said.

"People think that breakthroughs are made by a sudden stroke of genius, but in reality, making discoveries requires the long-term accumulation of knowledge and sharp intuition, so you can spot the tiniest anomalies and design the right experiments to rigorously probe the mechanisms behind them," he added.

For example, Bao's colleagues and students often contact him late at night to discuss the details of experiments and their results.

With a strong emphasis on attention to detail, basic science and communication, Bao's lab has become a cradle of quality chemists, training more than 100 PhD students and more than 40 post-doctorate researchers.

"China is rich in coal but lacking in petroleum, so the effective and clean conversion of coal and natural gas into chemicals and other products is a matter of national importance," Bao said. "Basic research should target key scientific questions that affect socioeconomic issues."

A world-renowned chemical physicist who specializes in basic research on catalysts and its creation, process and industrial applications. He is an academician at the Chinese Academy of Sciences, the Academy of Sciences for the Developing World and an honorary fellow of the Royal Society of Chemistry in United Kingdom.

Bao is currently the president of the University of Science and Technology of China. He received the first prize of the 2020 State Natural Science Award, China's highest academic accolade for basic sciences, for his groundbreaking work on "nano-confined catalysis".

CHINA'S SCI-TECH COMMUNITY DEDICATED TO OPENNESS

The new round of scientific, technological and industrial innovation being promoted globally is having a profound influence on the world's development pattern. The international environment is becoming more complex with rising uncertainty and instability, which poses unprecedented challenges to mankind.

Scientific and technological innovation serves as an important engine driving social development. All countries should uphold peace, development, cooperation and win-win partnership, and work together to cope with unknown risks and challenges.

China's sci-tech community has always adhered to the concept of openness, cooperation and innovative development. It focuses on frontier science and technology, the main economic battlefield, major State needs and the improvement of people's lives and health.

The community is also committed to improving the innovative progress of science and technology, as well as stimulating the vitality of sci-tech innovation, promoting the spirit of scientists, and strengthening the ethical governance of science and technology.

It has proactively participated in global sci-tech governance and contributed to the building of a community with a shared future for humankind.

The China Association for Science and Technology, which is the largest non-governmental organization of sci-tech professionals in China, serves as a bridge to link millions of Chinese scientists, engineers and other professionals working in this field.

One major task of the association is to conduct academic exchanges and promote the construction of world-class sci-tech journals and institutions, in a bid to give full play to its irreplaceable role in academic innovation.

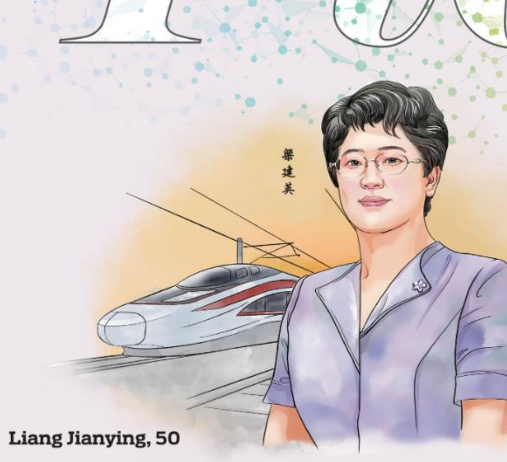
The association insists on carrying forward the scientific spirit, popularizing scientific knowledge, organizing science education activities among the youth, and improving the scientific literacy of all citizens. The proportion of Chinese citizens with "scientific qualities" increased from 3.27 percent in 2010 to 10.56 percent in 2020.

Moreover, it highlights international sci-tech exchanges and cooperation. The association and its branches nationwide have joined 372 international sci-tech organizations, aiming to participate in global sci-tech governance and play a unique role in non-governmental international sci-tech exchanges and cooperation. Although profound changes have been taking place in both the domestic and international environment on the new stage of development, China will strengthen its confidence and actions to increase opening-up and cooperation.

Wan Gang, president of the China Association for Science and Technology

Pioneers

On May 30, China celebrates its sixth annual National Science and Technology Workers' Day. It is a day that commemorates China's latest scientific and technological achievements and the innovative, insightful and industrious workers that created them. Highlighting this year's theme of "striving for innovation excellence" , "achieving self-reliance and strength" in sci-tech, we have profiled nine noted Chinese scientists and engineers. Each has pushed the global scientific frontiers, spurred economic growth, fulfilled the country's crucial needs or safeguarded public health. Together, they represent a diverse and inclusive group portrait of China's scientific and engineering community. Despite their different ages, genders and backgrounds, they are all pioneers of our time and the pride of a nation.



Liang Jianying, 50

From a common technician to the chief engineer behind some of China's biggest technological innovations in transportation, Liang Jianying said she was fortunate to have worked in a time of rapid development in China's high-speed railway sector, which has provided ample opportunities for her team's ingenuity and efforts to shine.

In 2004, China published a plan to greatly expand the nation's railway system, thus kick starting the era of high-speed rail. China had to import high-speed trains at that time, and Liang soon realized the importance of building innovation capability and being self-sufficient in science and technology.

Two years later, Liang was tasked with designing her first 300 kilometers per hour high-speed train. "The shoulders of giants can be shaky and hard to stand on, we have to become giants ourselves," she said.

But designing a bullet train is no easy task. A single train can contain over 500,000 components, and improving its speed from 200 to 300 km/h means overcoming numerous technical obstacles.

The challenge did not faze Liang, and by December 2007, she created China's first high-speed train with a speed between 300 to 350 km/h. In 2010, she broke the world speed record at the time with CRH380A, a bullet train from the *Hexie* series with an operation test speed of 486.1 km/h.

"China is a vast country with huge traffic demand and complex geography. With so much support from my country, if I was not able to create the best train in the world, then I would be letting the nation down," Liang said. This is the belief that compelled Liang to achieve excellence throughout the years.

In 2017, the new and improved *Fuxing* series bullet train entered service, gradually becoming the mainstay of China's high-speed rails. As of the end of 2021, there were 1,191 *Fuxing* trains in operation and they had safely served over 1.37 billion passengers across approximately 1.36 billion kilometers.

On July 20, 2021, after five years of hard work by Liang and her team, China's first 600 km/h high-speed magnetic levitation train made its debut in Qingdao, Shandong province. It is one of the fastest examples of ground-based public transportation in the world to date.

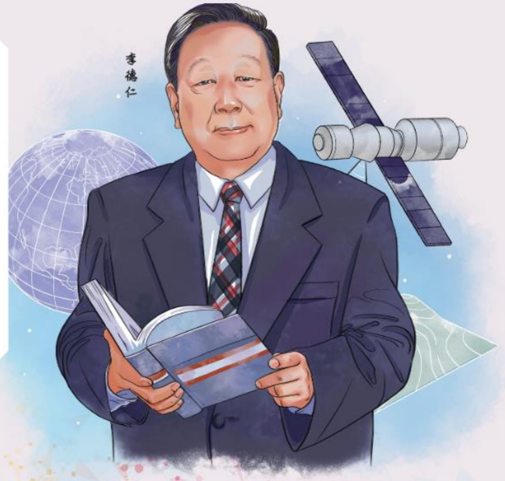
"I believe that in the foreseeable future, there will be more Chinese high-speed trains with independent intellectual property debuting new styles and speeds," she said.

The vice-president and chief engineer of China Railway Rolling Stock Corporation Qingdao Sifang, the company behind the *Hexie* and *Fuxing* bullet trains, which have propelled China to the position of a global powerhouse in high-speed trains.

Liang and her team received the Special Prize of the 2015 State Scientific and Technological Progress Award for developing the Beijing-Shanghai high-speed railway network. She is currently the director of the National Innovation Center of High Speed Train.

A world-renowned scientist in photogrammetry and remote sensing. He is an academician of the Chinese Academy of Sciences and the Chinese Academy of Engineering, and an honorary member of the International Society for Photogrammetry and Remote Sensing.

Li, also a professor at Wuhan University, Hubei province, has won numerous prestigious awards, including the first prize of the 2020 State Scientific and Technological Progress Award and the ISPRS Brock Gold Medal Award for his outstanding contributions to photogrammetry. He has trained over 200 doctoral students, and is one of the key contributors that transformed China into a global geomatics powerhouse.



Li Deren, 83

"Love my China, strengthen my country" is the first tenet of the family teachings passed down by the great grandfather of renowned geomatics and geospatial information scientist Li Deren.

Li said he is glad to have lived up to that motto. At the age of 83, he is still serving his country through his life-long passion of surveying and processing geographic information using satellites and other remote-sensing technologies.

Last year, Li and his team received the first prize of the 2020 State Scientific and Technological Progress Award for developing advanced Earth observation systems, which can swiftly provide high-definition images and information for applications including disaster relief, infrastructure construction and environmental protection.

The project took Li's team of nearly 100 experts a total of 15 years to complete. Now, Li is hoping to improve that system further and create more digital products that can help countries around the world achieve sustainable development.

"Science should serve the country, and geomatics is a discipline critical to national security and economic development," he said.

Collecting geographic data on nature and human activities helps experts and policymakers to arrive at informed decisions on sustainable development and other important needs, he added.

In March, Li and his team at the State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing at Wuhan University, Hubei province, published China's first global radar orthophoto.

An orthophoto is an aerial or satellite image without geometrical distortions, allowing scientists to measure the true distances of features within the photograph.

This makes an orthophoto a key tool for agriculture, resource management, urban planning and other industries.

Li said the map covers a land area of more than 200 million square kilometers, and the scientific data from the map are available for researchers around the world.

"We want to remove our reliance on foreign data, and pursue technological innovation to become more self-reliant," he said.

"The most important element of the scientific spirit is to seek truth from facts. We should respect science and scientists, but we can't place blind faith in existing teachings or foreign technologies."

"We have to make original breakthroughs that can solve the critical needs of the country," he added.

Li Yu, 78

One intriguing fact about China's historic victory over extreme poverty is that part of its foundations were built on edible fungi and decades of innovative research.

Revitalizing rural China, promoting green development and pushing the envelope to better research and serve the nation's strategic needs are themes highlighted in the 14th Five-Year Plan (2021-25).

Li Yu, a noted mycologist and an academician at the Chinese Academy of Engineering, managed to achieve all these goals using tiny mushrooms.

"This is because growing fungi is not labor-, time- or resource-intensive. They are easy to plant and they require little investment," he said. "They grow very fast and they yield good financial returns. Thus, it is a first-choice industry for poverty alleviation."

China's agricultural industries produce a huge amount of plant stalks and animal manure every year, which can pollute the environment if not handled properly, Li added.

"Now, we can turn agricultural waste into fertile bags of nutrients for growing fungi," he said. "After they are harvested, we can process what's left in the bags into fertilizer, effectively turning trash into treasure."

"This will build a sustainable cycle in which farmers earn extra income from waste, consumers get tasty and healthy fungi products and the environment is cleaned in the process."

Since 2012, Li and his students have spent over 280 days most years traveling to 40 significantly impoverished regions across seven provinces to introduce fungi species and teach villagers how to use modern equipment and techniques to cultivate them.

His efforts have blossomed into a 35 billion yuan ($5.38 billion) production and manufacturing industry that features unique products made from fungi including chips, supplements, tea and ice cream, all while lifting 35,000 families from more than 800 villages out of poverty.

"Scientists, especially agricultural scientists, should not farm on the blackboard," Li said. "They need to get their feet in the field and use their research to help farmers become rich and live better lives."

A world-renowned mycologist who specializes in engineering and industrialization of fungi science and edible fungi. He is an academician at the Chinese Academy of Engineering and the president of the International Society of Medicinal Mushrooms.

His research has made substantial contribution to China's poverty alleviation effort, lifting hundreds of villages out of absolute poverty. In 2021, he received the honorary title of National Poverty Alleviation Models for his success in poverty eradication.

Tu Youyou, 92

This year marks the 50th anniversary of the discovery of artemisinin, the active compound that serves as the backbone for the most common and effective antimalarial treatment today.

According to the World Health Organization, about 240 million people in sub-Saharan Africa have benefited from artemisinin-based combination therapies.

By the end of 2021, China had trained tens of thousands of anti-malaria technicians for developing countries and built malaria prevention and control centers for 30 countries.

During the 1940s, China was ravaged by malaria, with nearly 30 million cases each year. In June 2021, the WHO announced China had eliminated this disease within its borders.

Tu Youyou, a 2015 Nobel Prize laureate for her discovery of malaria drug artemisinin, was thrilled to hear the WHO's announcement. But a sense of urgency and responsibility quickly followed, prompting Tu to ask her colleagues how many countries had not eradicated malaria and how Chinese researchers could help.

Last month, during a meeting with officials from the National Administration of Traditional Chinese Medicine, Tu said the number of cases and mortality rates of malaria have rebounded in some parts of the world.

In 2020, there were an estimated 241 million cases of malaria worldwide, claiming around 627,000 lives, according to the WHO. The African region carries a disproportionately high share of the global malaria burden. It was home to 95 percent of malaria cases and 96 percent of malaria deaths in 2020.

The mosquito-borne infectious disease remains a serious public health challenge, and it is important for the international community to enhance collaboration toward achieving a malaria-free world, she added. At the age of 92, Tu may not be able to work as hard as she did decades ago, but she reads monthly briefs on her team's research and often offers her advice on key projects.

Understanding how artemisinin acts on the malaria parasite, how to overcome drug resistance of artemisinin-based combination therapies and whether it can be used to treat other diseases are some of the focal points of her team's research. As Tu often said, artemisinin is a gift given by China to the world. Today, artemisinin stands as the embodiment of the innovative use of traditional Chinese medicine for the benefit of humanity.

A Chinese pharmaceutical chemist whose discovery of the malaria drug artemisinin has saved millions of lives across the globe. She received the 2015 Nobel Prize in physiology or medicine, becoming the first Chinese to win this award.

She is also the recipient of the 2016 State Preeminent Science and Technology Award, China's highest honor for a scientist, and the Medal of the Republic, China's highest state honor.

Wang Yingjun, 68

For Wang Yingjun, the greatest joy is to see her work on biomedical materials can help so many patients and seniors live a better life. Over the last four decades, Wang has focused on creating and improving biomedical materials and high-end medical equipment.

She invented the implant for regenerative restoration for load-bearing bone with large defects, which has led to products that have been used in over 400 hospitals in China and Europe, saving more than 300,000 patients from amputation and disability.

Now, Wang and her team are spearheading a demonstration center based on the Biomaterials Innovation and Cooperation Platform to develop and commercialize new biomedical materials and high-end medical equipment.

In the 1980s, there were not many Chinese researchers working on bioactive materials. At the time, the living and lab conditions were poor and Wang had no one to help her, but she loved her work so much that she would often stay up all night in the lab, or pour water on her dorm bed as cooling during the hot summer months.

"Once I entered this field, I couldn't help but to keep working hard, overcome obstacles and contribute wholeheartedly," she said. "Younger generations of scientists are becoming more capable, but the fighting spirits, dedication and principles from the older generations should be passed down and adopted."

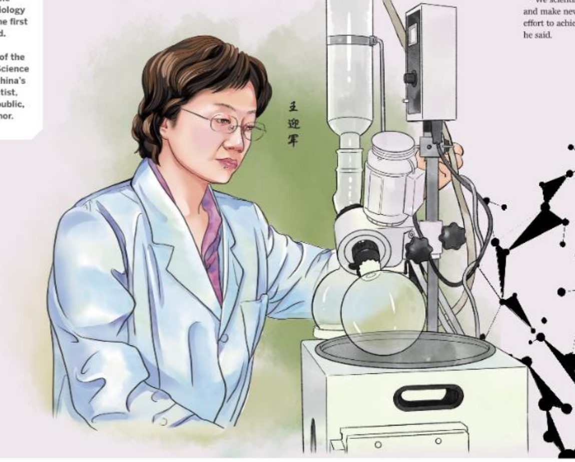
"Scientific research is doing what others have not done, so there won't be innovations without the innovative spirit," she said. "There is no shortcut or short sighted pursue of success when making innovations."

At the same time, a successful scientist should always be curious and hungry for new knowledge, which is important for inter-disciplinary research such as biomedical materials.

New technologies such as artificial intelligence, big data, 3D printing, as well as new advances in biology and life sciences, are contributing to the development of biomaterial research, [illegible]

An academician of the Chinese Academy of Engineering and the director of the National Engineering Research Center for Tissue Restoration and Reconstruction.

She is a noted biomedical material expert who has developed original breakthroughs and products in bone, teeth, tissue engineering and regenerative medical materials.



Zhu Tao, 49

Zhu Tao said recently that CanSino Biologics has been working hard to bring the future of COVID-19 vaccinations, where they may replace the "jab" with a "huff", the procedure being as simple as "sipping coffee".

The recipient takes a deep breath from a cup containing the aerosol of the vaccine, holds the gas for around five seconds, and slowly breathes out. The whole process takes around 10 seconds and is completely painless, making it ideal for individuals who are scared of needles, he said.

The vaccine has recently entered late-stage clinical trials. Preliminary data show that it is safe and can deliver broad protection against the COVID-19 virus and its mutated strains.

Inhaled or nasal spray COVID-19 vaccines are widely regarded as a game changer in the global fight against the highly transmissible Omicron variant, which primarily targets the upper airway. These types of vaccines will bolster the mucosal immunity of the respiratory tract, thus providing a first line of defense against the pathogen.

As a result, researchers in the United States, Canada, the United Kingdom, India and Japan are developing these types of vaccines. CanSino Biologics is one of the global front-runners in the race.

"We have always valued scientific and technological innovation as the No 1 source of productivity," he said. He added that an innovative spirit, a strong will to overcome difficulties, and conducting research in a rigorous and thorough manner are key to success for scientists.

"We scientists should continue to nurture quality talents and make new innovations, and contribute our insight and effort to achieving self-reliance in science and technology," he said.

A vaccine expert and the chief scientist at CanSino Biologics. He is a member of the Chinese People's Political Consultative Conference National Committee, China's highest political advisory body.

Zhu is one of the key scientists behind Convidecia, a single-dose adenovirus-based viral vector vaccine for COVID-19, which has been listed by the WHO for emergency use.

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