



# Marching Towards Sci-tech Powerhouse

## Editor's Note:

Since the 18th National Congress of the Communist Party of China in 2012, China has achieved remarkable milestones, from groundbreaking space exploration missions to advancements in fundamental research. These endeavors have expanded human knowledge and led to improvements across various sectors, contributing to the well-being of people domestically and globally.

China's sci-tech progress has grown significantly, driven by the dedication and enduring spirit of its scientists. Their contributions not only serve national interests but also advance global innovation, particularly amidst the unprecedented challenges of our time.

In this special edition, we explore the significance of the recent combined meeting of the national sci-tech conference, the national science and technology award conference, and the assembly of the Chinese Academy of Sciences and the Chinese Academy of Engineering to gain more insights and inspiration for accomplishing further breakthroughs in science and technology.

## Scientist Spirit Leading Sci-tech Advancement

By YU Haoyuan & BI Weizi

Science and technology capabilities of China have become globally influential over the past decades thanks to the unremitting efforts of generations of scientists and the enduring spirit that they passed down.

### Serving the nation with dedication

Chinese scientists have an illustrious tradition of serving the country. Their efforts made it possible to explore the boundless space with the Shenzhou manned spacecraft, plumb the deep sea with the Jiaolong manned submersible, and observe the distant universe with the Five-hundred-meter Aperture Spherical radio Telescope (FAST).

The history of China's scientific development is full of dedicated scientists who stand out for their contributions.

Aerospace engineer Qian Xuesen gave up a successful career in the U.S. to return to China and became the "Father of Chinese Rocketry." Nan Rendong, the chief scientist and chief engineer of the FAST project, implemented it while battling cancer.

Scientists like Deng Jiaxian, Huang Xuhua, Huang Danian and Liu Yongtan, who made great contributions to China's sci-tech progress, shared a common spirit. They were patriotic, innovative and dedicated, and mentored the next generation.

### Benefiting the world with innovation

The scientist spirit also emphasizes serving socioeconomic development and the people.

As the world undergoes major changes unseen in a century, science workers are embracing the challenges brought about by the new wave of technological and industrial transformation and ensuring that their achievements benefit everyone.

Chinese agronomist Yuan Longping, known as "the father of hybrid rice," developed the first hybrid rice varieties in the 1970s. The rapid increase in crop yield enabled China to become self-sufficient in food, feeding its people — or 20 percent of the global population — though it has only nine percent of the world's arable land.

Yuan and his team donated crucial rice strains to the International Rice Research Institute in 1980, which provided a Chinese solution to the worldwide food shortage.

Phytochemist Tu Youyou proved the effectiveness of traditional Chinese medicine (TCM) in modern research. Following TCM texts, she extracted artemisinin from the herb wormwood to treat

malaria, a revolutionary herbal therapy that has been particularly impactful in Africa, where malaria is a major health issue. Her work has significantly reduced the malarial mortality rate across the continent, saving millions of lives, especially those of children. The Nobel Prize Committee, which honored her in 2015, includes her among the "women who changed science."

The work of Yuan and Tu has made them global icons of the scientist spirit. This spirit has contributed immensely to building a community with a shared future for all.

### Scientist spirit in new generations

Although Nan Rendong passed away, his spirit continues to inspire "star chasers" in Guizhou province in southwest China where FAST is located. His student Jiang Peng now leads the team operating the telescope and they have made numerous world-class scientific achievements. Thanks to observations using FAST, researchers have published 11 high-level papers in *Nature* and *Science*.

Several research teams named after veteran scientists have inherited their spirit, dedicating themselves to innovative research and achieving remarkable results. A team that made a geological and paleontological study on the Qinghai-Xizang Plateau, summarizing the basin evolution of the North Qiangtang Block, a terrane in Xizang autonomous region, was named after geologist Li Siguang. The world's first high-definition lunar geological atlas was drawn by a team named after renowned lunar scientist Ouyang Ziyuan. A highland biology research team, named after zoologist Xia Wuping, assembled high-quality chromosomal-level reference genomes for wild and domestic yaks.

Such milestones reflect China's gains in science popularization and education and the proactive role played by the numerous scientists and those who raise awareness about science. The trends indicate that this spirit will be carried on, encouraging further sci-tech development and promoting global cooperation in innovation.

Many Chinese scientists have gained international recognition for their contributions to global scientific research and technological innovation.

Xue Qikun, China's top science award winner this year, achieved breakthroughs in topological insulators and quantum physics, revitalizing China's research in these fields. Pan Jianwei led the successful launch of the quantum science experimental satellite Micius and his work laid the foundation for a global quantum communication network. Shi Yigong advanced structural biology in China and his research is crucial for understanding human disease mechanisms. Yan Ning discovered the structures and functions of important proteins in structural biology and helped bolster China's standing in biomedical research.

### Leaving an enduring legacy

From launching the first Chinese satellite 50

years ago to sending three taikonauts into space with Shenzhou 18, Chinese scientists have continued to conquer new frontiers, including sending a rover to Mars and bringing back samples from the far side of the Moon. The scientist spirit in these endeavors has become a legacy for future generations, igniting their passion for science and technology.

China's scientific literacy has significantly improved. By the end of 2020, 10.56 percent of the people had science literacy, which increased to 14.14 percent by 2023. The number of science popularization professionals and volunteers has also grown, reaching 1.99 million in 2022, up 9.26 percent from 2021. This has kept the spirit of science inheritance flowing.

The scientist spirit inspires China's sci-tech workers to strive for new heights. According to a report from the Institute of Scientific and Technical Information of China last September, Chinese scientists published 16,349 papers in top journals in 2022, representing 30.3 percent of the global total. China also maintained its leading position globally in the number of academic papers published in the world's most influential journals and held the second place for highly cited papers. These achievements have contributed significantly to the world of science.

Such milestones reflect China's gains in science popularization and education and the proactive role played by the numerous scientists and those who raise awareness about science. The trends indicate that this spirit will be carried on, encouraging further sci-tech development and promoting global cooperation in innovation.



Planned by WANG Junming, HE Yi, FANG Linlin. Edited by CHEN Chamyou, LONG Yun, SONG Ziyun. PHOTO: XINHUA & VCG

## Policies That Accelerated China's Progress

By Staff Reporters

China has been improving its science and technology policies to encourage R&D. For more than a decade, a series of important sci-tech policies and measures have been introduced:

- Top-level design documents to implement the innovation-driven development strategy and deepen sci-tech system reforms have been put into action. The Law on Progress of Science and Technology, the Patent Law, and other laws have been revised accordingly.
- At least 50 percent of the income generated from the commercialization of sci-tech achievements is given to researchers, and the proportion of research funding allocated to personnel has increased.
- The number of forms to be submitted to apply for key R&D programs has been reduced from 57 to 11, lessening researchers' paperwork burden.
- The evaluation system for sci-tech talent focuses more on innovation value, abilities, and contributions.

Ding Minglei, a researcher at the Chinese Academy of Science and Technology for Development, said effective implementation of science and technology policies has provided a solid institutional

foundation for innovation.

In recent years, the breadth and depth of sci-tech reforms have expanded, extending from science to economic and social development and national security. The connotation and boundaries of the reforms have been continuously enriched.

China has strengthened both technological and institutional innovation, formulating and implementing relevant plans, and promoting the improvement of the legal and regulatory framework. This provides institutional guarantees for achieving sci-tech self-reliance and self-strengthening at higher levels.

To reduce administrative burdens and distribute authority more effectively, reforms in the management of research project funds have increased the proportion of indirect costs (including management fees, performance expenditures, and research operational costs), delegated budget adjustment authority, and carried out pilot reforms for a "green passage."

The Ministry of Science and Technology, along with other departments, has launched a nationwide initiative, simplifying the process for project applications, material submissions, and expense reimbursements, which enables researchers to focus on their work.



Talent assessment now emphasizes innovation value, capability, and contribution to integrating science, technology, and the economy, motivating researchers further. Efforts are being made to advance the commercialization of sci-tech achievements, enable researchers to gain income from their research results, and implement knowledge value distribution policies to stimulate innovation and entrepreneurship.

Official data shows that in 2023, China's total social R&D expenditure reached 3.3 trillion RMB, with an R&D intensity of 2.64 percent. The number of high-tech enterprises increased from 49,000 in 2012 to 465,000 in 2023. Looking ahead, science and technology policies will be further refined to develop an efficient, open, and coordinated national innovation system.

## Innovation Improves People's Well-being

Edited by TANG Zhexiao

Today, people have come to rely on science and technology not only for convenience, but also for a better life in the fast-paced world.

Currently, as one of the world's most inventive countries, China's sci-tech innovation in a variety of sectors is playing an important role in improving the well-being of its people.

A major recent achievement is the C919, the first jet-type trunk airliner independently developed by China with international airworthiness standards. China owns the intellectual property rights to it, which has boosted the country's competitiveness in the global aviation market.

Data from the Commercial Aircraft Corporation of China showed that as of May 27, 2024 the five C919 jetliners of China Eastern Airlines had completed 2,181 flights, accumulating 6,090 flight hours across three routes, and had transported over 276,000 passengers in the past year.

East China's Shanghai, on December 24, 2023 saw China's first domestically built large cruise ship, named Adora Magic City, set sail on a trial voyage. This journey marked a breakthrough for the country's high-end manufacturing and the dream of Chinese people of boarding a domestically produced large cruise ship and exploring the world at sea became a reality.

China owns the world's longest and most extensively used high-speed railway, with a total length of 45,000 km as of 2023, according to China Railways.

At a base in north China, researchers are pursuing a futuristic means of transportation, an ultra-high-speed maglev train. Adopting magnetic levitation technology and traveling in low-vacuum tubes, this maglev train could reach speeds of up to 1,000 km per hour if successful.

China has emerged as a leader in renewable energy, with its solar photovoltaic capacity installations last year totaling as much as the rest of the world's combined in 2022.

Hualong One, also known as HPR1000, was put into commercial operation in 2021. It marked a milestone for the development of the country's nuclear power, making China the fourth country to boast indigenous Generation III nuclear power technology following the U.S., France and Russia. The electricity generation of Hualong One unit is equivalent to reducing the consumption of standard coal by 3.12 million tons and emissions of carbon dioxide by 8.16 million tons per year.

After the world's first 16 MW offshore wind turbine came online in July 2023, in a global first, an 18-megawatt semi-direct drive offshore wind turbine was successfully installed in a coastal test base in south China's Guangdong province on June 5. Its average annual power generation is up to 72 GWh, enough to power around 36,000 households.

China's BeiDou Navigation Satellite System (BDS) played an important role in the process of achieving mass application of satellite communication. After completing global coverage in July 2020, China has accelerated the BDS applications for civil use, tapping into the expensive satellite technology for the mass consumer market.

By 2035, the country plans to build a next-generation BDS-4 system with greater precision and global reach.

Technologies such as big data and BDS have also been widely applied in crop production, and agricultural technology is a key driving force to boost China's agricultural modernization.

Data from the Ministry of Agriculture and Rural Affairs showed the mechanization rate of crop cultivation and harvesting nationwide has exceeded 73 percent to date, and the number of agricultural machinery and equipment equipped with BDS has reached 1.8 million units.

High-tech applications are also flourishing nationwide. For example, a 5G base station established at an altitude of 6,500 meters on Mount Qomolangma in April 2020, makes it the highest-altitude 5G such station in the world. Two months later, the country's first underground 5G network in Shanxi province set a world record as the deepest underground 5G network.

Today, with over 3.7 million 5G base stations installed nationwide, the large-scale application of 5G in China has greatly benefited both individuals and businesses. Bringing significant convenience and opportunities, China's sci-tech innovations will continue to improve the well-being of an increasing number of people, both Chinese and others worldwide.

## Contribution to Global Science with Breakthroughs

Edited by GONG Qian

In the sci-tech field, China has attained a number of significant achievements since 2016, playing a leading role in the global sci-tech community.

### At the forefront of critical research

Over the past eight years, Chinese scientists have tackled cutting-edge scientific issues and completed a series of crucial basic research tasks, consolidating basic research.

In fundamental physics, China has achieved international leadership in areas such as quantum communication, superconductivity and topology in physics, and magnetic confinement long-pulse plasma.

In 2016, China launched the world's first quantum satellite "Micius," named after an ancient Chinese philosopher. "It's a huge achievement for quantum entanglement and quantum science," physicist Thomas Jennewein of the University of Waterloo in Canada told *Science News*. "China is now clearly taking the world leadership in this area of quantum communication."

Several years later, Chinese scientists set up the world's first integrated quantum communication network that combines 700 optical fibers on the ground with two ground-to-satellite links and realized quantum key distribution between more than 150 users over a combined distance of 4,600 km.

In 2017, China successfully created from somatic cells the world's first cloned macaques, named Zhong Zhong and Hua Hua. With this success it became a pioneer in disease and brain science research, using cloned macaques as animal models.

China has also achieved significant and historic breakthroughs in deep space exploration. For example, the ascender of China's Chang'e-6 probe lifted off from the lunar surface on June 4, 2024, carrying samples from the moon's far side, an unprecedented feat in lunar exploration history. Other major achievements include Zhurong, the first Mars rover landing on the red planet, and completion of the Tiangong space station. Those feats have greatly contributed to the exploration of the mysteries of the universe.

### Mega projects for advanced research

China has achieved remarkable progress in both the quantity and quality of mega science projects, promoting basic research and innovation.

In November 2020, China's manned submersible Fendouzhe, which means "Striver", completed its 10,000-meter sea trial. During the expedition, the submersible set a new record by diving to a depth of 10,909 meters in the Mariana Trench. This marked China's entry into the top echelon of deep-sea scientific research. The domestically developed Fendouzhe has greatly improved the independent innovation level of China's deep-sea equipment technology.

In August 2022, a hybrid magnet built by scientists

of the Steady High Magnetic Field Facility in Hefei, east China's Anhui province, produced a steady field of 45.22 tesla, the highest steady magnetic field by a working magnet in the world. This broke the previous record of 45 tesla by U.S. researchers in 1999.

This achievement is a milestone in magnetic technology. Stronger magnetic fields help scientists see the internal structure of materials more clearly, leading to a better understanding of the world and the development of new technologies.

The experimental advanced superconducting tokamak (EAST), or the Chinese "artificial sun" achieved a steady-state high confinement plasma operation for 403 seconds on April 12, 2023. In the same year, Chinese scientists unveiled a quantum computer prototype, known as "Jiu-zhang 3.0," with 255 detected photons. It could solve Gaussian boson sampling problems 10 quadrillion times faster than the world's fastest supercomputers at that time.

As of April 2024, China's Five-hundred-meter Aperture Spherical Radio Telescope (FAST) had identified more than 900 new pulsars since its launch in 2016. Using the world's largest single-dish radio telescope, Chinese scientists have found evidence of the existence of nanohertz gravitational waves. The discovery is pivotal in understanding the structure of the universe and the behavior of supermassive black holes, paving the way for future exploration of gravitational waves.

With its commitment to innovation and research, China is poised to unlock new frontiers in various fields and take its sci-tech strength to a higher level to support national development and benefit the world.

