

20 SEPTEMBER 2018

USTC

University of Science and
Technology of China
60th anniversary

Reflecting on a journey of
discovery and innovation

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nature research
CUSTOM MEDIA

2017

Named as a Class A university in the national Double First-class initiative



2016

Launch of Micius, the first quantum satellite



1999

Became one of the first batch of universities selected for the national Project 985



1998

Joined the CAS Knowledge Innovation Programme



1970

Relocated to Hefei, Anhui's capital



1978

Started China's first graduate school and the first class for the gifted young



2003

Founding of the Hefei National Laboratory for Physical Sciences at the Microscale



1983

Launched the National Synchrotron Radiation Laboratory, the first big science facility established in a Chinese university



1995

Selected for Project 211, the National Key University programme

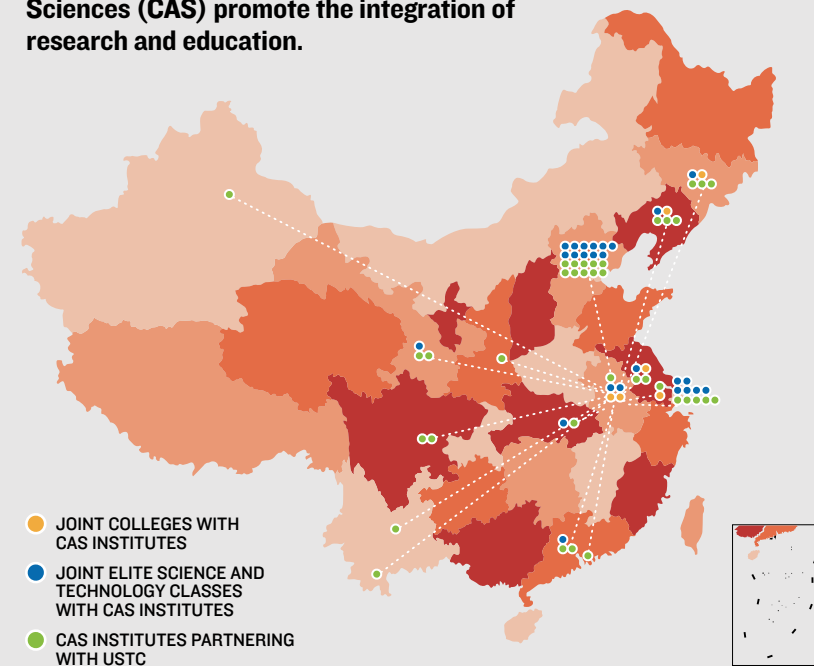


1958

USTC was founded in Beijing



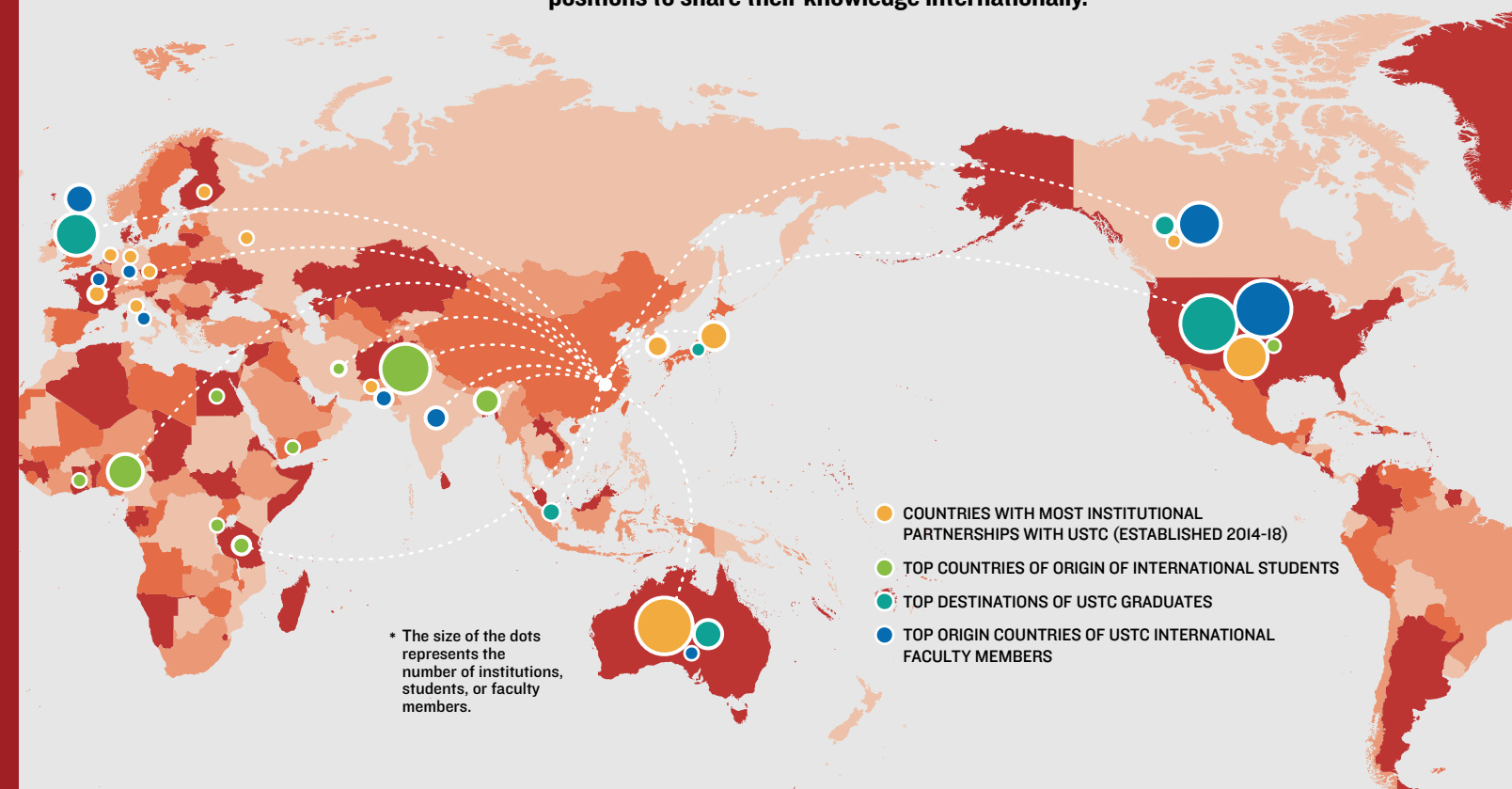
Close ties with the Chinese Academy of Sciences (CAS) promote the integration of research and education.



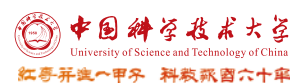
USTC

BROADENING COLLABORATIONS IN CHINA AND THE WORLD

USTC has established partnerships with institutions around the world and has attracted students and faculty from far and wide. Many of its own undergraduates and postgraduates have taken positions to share their knowledge internationally.



SERVING THE COUNTRY IN SCIENCE AND EDUCATION FOR 60 YEARS



60 YEARS OF USTC BRILLIANCE

The University of Science and Technology of China (USTC) is unique. Governed by the Chinese Academy of Sciences (CAS), this top research university in China combines its education and research capabilities with the vast resources of CAS. Because of this, USTC can focus on developing cutting-edge science and technology while educating the world's future leaders, gaining a worldwide reputation for its academic excellence.

USTC was established by CAS in 1958 as part of a government strategy to respond to increasing science and technology needs. Since then USTC has set up creative programmes that integrate pioneering research with innovative technologies. It has also been the originator of bold moves forward in higher education reform, including: establishing China's first graduate school; initiating a programme for gifted young students; building facilities for major science projects, such as the National Synchrotron Radiation Laboratory; and pioneering international collaboration. Already part of Project 211 and Project 985, USTC has now been chosen to become part of the national 'Double First Class' initiative, which is designed to support institutions as they become world-class universities.

USTC has already made remarkable progress, including a series of breakthroughs in quantum information, high-temperature superconductivity, nanotechnology, as well as in interdisciplinary areas, including artificial intelligence (AI), Earth and environmental sciences, and life sciences and health. Its researchers led the world's first satellite mission designed for quantum science experiments and developed the prototype quantum computer, eclipsing classical earlier generation examples. Works on iron-based superconductors and on manipulating multi-photon entanglement for secure quantum communication have won first prizes of the National Natural Science Awards. The university also participated in the development of China's first dark matter particle explorer, the Wukong satellite.

Concerted effort at USTC has pushed 12 research fields into the ranks of the global top 1%, according to Essential Science Indicators data. Among these, physics, chemistry, materials science and engineering are all listed in the top 0.1% globally.

The latest Times Higher Education Ranking listed USTC as 23rd among Asia Pacific's universities, and the third in mainland China.

Placing talent at the core, USTC's unique educational model and its partnership with CAS have also encouraged the growth of interdisciplinary research. Novel engineering programmes featuring quantum information technology, AI and big data, and health science are currently in development.

The university is also a magnet for bright young researchers, who complement its many well-established researchers, with the former accounting for 50% of its faculty team. Its reservoir of high-level talent includes 49 CAS or Chinese Academy of Engineering (CAE) members.

USTC is also committed to meeting regional

and national development needs. Since relocating in the early 1970s from Beijing to Hefei, the capital of central China's Anhui province, it has boosted science and technology development in the city and the region by attracting global innovators and resources. With established national laboratories, engineering centres and big science research platforms, the university is helping to drive Hefei's push to become one of China's three national science centres, along with Shanghai and Beijing.

Among its endeavours is a newly established Faculty of Life Sciences and Medicine, which is a partnership with provincial government, the National Health Commission and CAS to explore a novel model that integrates basic science and engineering with medicine. USTC is also mobilizing resources from CAS research institutes, universities and the industry to build a national laboratory on quantum information.

After 60 years of remarkable development, USTC looks forward to a new chapter of fantastic growth. ■

LOOKING BACK ON THE ROAD TO SUCCESS

IN CONVERSATION WITH BAO XINHE, USTC PRESIDENT

● Under what circumstances was USTC founded?

During the science and technology boom in the late 1950s, the Chinese government identified the need for a new research university featuring science and technology. In 1958, the Chinese Academy of Sciences (CAS) came up with a proposal for such an institution, and, four months later, USTC was founded in Beijing. CAS leveraged its resources to support the new university and encouraged the integration of its institutions with USTC departments. Having attracted some of China's most renowned scientists at the time, such as Yan Jici, Hua Luogeng and Hsue-Shen Tsien, USTC's founding was a milestone in the history of Chinese science and education. We have quickly built our reputation in academic communities nationally and abroad. In the 1990s, we were among the first group of universities selected for the national Project 211 and Project 985 initiatives.

● What makes USTC unique?

We look for quality and emphasize elite education. Our subject areas may not be completely comprehensive, but we have 12 subjects ranked among the top 1% globally according to the Essential Science Indicators, including four in the top 0.1%. Our undergraduate student body is not huge, but within it we have a group of science and technology leaders, with approximately one CAS or CAE member per 1,000 graduates.

Our uniqueness is also defined by our core values, which emphasize student education, research excellence, and serving our society. Our professors, both young and senior, all teach undergraduate courses and enjoy a close connection with students. We encourage curiosity-driven exploration, interdisciplinary exchange and collaboration in research. Our educational and academic programmes are designed to serve society. From our founders to our graduates, USTC people have helped China become a research powerhouse.

● How does USTC use science and technology to serve China?

USTC has always been committed to serving national strategic needs. In the early years, we supported defence projects via our research and education programmes. These days, our breakthroughs in quantum information, high-temperature superconductivity, nanotechnology, AI and speech recognition, Earth and environmental sciences and life sciences have boosted technological innovation. We have also played a key role in major national projects, such as the Wukong satellite, Micius mission, and the Experimental Advanced Superconducting Tokamak.

We have been instrumental in establishing the Hefei Comprehensive National Science Centre. Our next endeavours aimed at driving regional and national development include: the quantum information national laboratory, which is under construction and a partnership with CAS; the new Faculty of Life Sciences and Medicine, which integrates science, engineering and biomedicine; and the development of 'new engineering', a field that focuses on big data, AI and information sciences.

● How does USTC integrate research and education?

Our advantages are bolstered by our close connection with CAS, with many of our chairpeople also acting as directors of CAS institutes. This allows our students to be deeply involved with CAS research projects. We also collaborate with CAS to pilot talent training reforms and explore the cultivation of innovation through a network that integrates research and education. This has led to 11 elite science and technology classes, nine joint classes with CAS institutes and six joint colleges. By pioneering the class for gifted young students 40 years ago, which is now set to become the School of the Gifted Young, as well as graduate education in China, we have always been a forerunner in Chinese higher education reform.

● What are your development plans for USTC?

Joining the national 'Double First Class' initiative provides us with new opportunities for growth. We are striving to build a world-class university with unique characteristics, and to eventually become a key centre for basic research breakthroughs and innovation, a national science and education hub, a global platform for academic exchange, and a source of innovative ideas.

We are now building a USTC high-tech park, which, together with our other efforts, will link research with talent training and a translation pipeline. We also have plans to broaden our international exchange and enhance our societal impact.

As we celebrate our 60-year anniversary, we will bring together our alumni and friends from all circles to create a bright future for USTC. ■



Bao Xinhe,
USTC
president

CROSSING PHYSICAL BOUNDARIES

The University of Science and Technology of China (USTC) has forged an excellent reputation for basic research in physical sciences. Now it is integrating those strengths to develop exciting cross-disciplinary innovations.

Computational geometry studies by USTC mathematicians have applications in 3D printing.

MATHEMATICS

Mathematics, as the foundation of many physical science subjects, is the bedrock of USTC's development. The university reorganized its maths department into the School of Mathematical Sciences (SMS) in 2011, which is now a leader in China's mathematical research and education.

The school's outstanding mathematicians are exploring new possibilities in algebra and algebraic geometry, differential geometry, graph theory, dynamic systems, mathematical physics, partial differential equations, and probability and statistics. Their research results have important implications to many physical science and engineering fields. Based on theories such as spline functions, geometric modelling and sparsity optimization, the computational geometry group has developed a series of novel algorithms and methods for cost-effective 3D printing, light-weight and interlocking structure designs, shape decomposition, and customized mechanical structure design. These works, published in top journals, have also led to patented technologies, making an impact in both the academic community and the fabrication industry.

Other breakthroughs by SMS mathematicians include: introducing Higgs de-Rham flow, a fundamental notion in arithmetic and algebraic geometry, which supports use of the Hodge theory; establishing the connection between dynamic systems and combinatorial number theory by finding relations among the set of common differences of arithmetic progressions in a 'big' subset of integers and higher-order, almost automorphic systems; proving the Bando-Siu conjecture in differential geometry; and deriving Gaussian curvature estimates for the convex level sets of p-harmonic functions.

Works by SMS scholars have led to around 150 papers published each year in journals listed in the Science Citation Index (SCI), including top journals of the field, such as *Annals of Mathematics* and *Inventiones Mathematicae*, and numerous national awards. Several USTC mathematicians have been invited to address the International Congress of Mathematicians (ICM). SMS also regularly hosts mathematicians from around the world, and organizes national and international conferences to promote global exchange. ■

PHYSICS

USTC has one of the most comprehensive physical science portfolios in China. Its School of Physical Sciences studies small particles and atoms, as well as astronomical bodies and the universe, covering everything from theoretical physics to photonics engineering, and from microelectronics to biophysics.

Many of its programmes were established as USTC was founded, in 1958, by renowned scientists of the time, such as Yan Jici and Qian Sanqiang. Today, USTC has integrated its physical science strengths and established advanced research platforms, including Hefei National Laboratory for Physical Sciences at the Microscale (HFNL), the National Synchrotron Radiation Laboratory (NSRL), and key laboratories of the state, the Chinese Academy of Sciences (CAS) and the province. With these platforms, the school has achieved remarkable research results, particularly in quantum communication and computation, superconductivity, and single-molecular physics.

A research group led by Pan Jianwei, a CAS member, seeks to apply basic theories in quantum mechanics into quantum communication, computation and precision measurement. Notably, Pan's research on the entanglement of photons has provided a possible solution to secure long-distance communication, promoting its real-world application. To achieve inter-continental quantum communication, Pan led the development and launch of Micius, the world's first quantum science satellite, a success in all planned experiments. By manipulating multi-photon entanglement, the core of quantum computation, Pan's group has also tested all the major quantum algorithms, and developed the first photon-quantum computer prototype which outperforms early-generation classical computers.

USTC work has improved computing power by considerably lengthening the state of quantum superposition, or the coherence time, of electron spin in a noisy environment. The team, led by CAS member, Du Jiangfeng, realised the prolonged quantum states through pioneering decoupling technology, which they also applied for quantum precision measurement. Using the diamond nitrogen-vacancy centre as a probe, in a world first, they obtained the paramagnetic resonance spectra of single protein molecules in room-temperature environment and disclosed the underlying kinetic properties. This was hailed as an important milestone toward imaging

individual proteins in living cells in real time.

The USTC team, led by CAS member Guo Guangcan, has focused on technologies for quantum cryptography, quantum chips and simulators. They simultaneously observed both the particle and wave natures of photons in experiments, challenging the complementarity principle proposed by Bohr. Their achievements also include developing China's first fibre quantum key system; entangling eight photons using ultra-bright photon sources; and creating the solid-state quantum memory with the world's best performance.

Particle and nuclear physics explores composition and interactions at the sub-atomic scale. The State Key Laboratory of Particle Detection and Electronics at USTC provides leading technologies in support of the development of the field. Its researchers have contributed to some major breakthroughs of the STAR experiment at the Relativistic Heavy Ion Collider (RHIC) in the Brookhaven National Laboratory, including developing the time-of-flight spectrometer that increases the particle identification reach, discovering the anti-helium-4, the heaviest antimatter nucleus, and measuring antiproton interactions. Other projects include work on the Higgs boson particle discovery, and constructing the Beijing Spectrometer III detector.

In plasma physics, a 20-plus member USTC group has established the Keda Torus eXperiment (KTX), China's only reversed field pinch (RFP) device that magnetically confines plasma. Designed and built entirely in China, KTX has high Ohmic power, high beta ratio, and automatically maintains magnet-heat balance. The device facilitates cutting-edge fusion research and theoretical and experimental research on three-dimensional toroidal physics. Its size and function also make KTX an ideal platform for training researchers on nuclear fusion.

The USTC foray into soft matter and biophysics covers everything from non-crystal solids, quasi-crystal and crystallization to dynamics of bacterial behaviour and flagellar motors. This area uses physics to solve biological questions and is integral to USTC's interdisciplinary efforts.

Using simulation and theoretical analysis, USTC researchers have studied the structure of non-crystal solids, or glass, allowing for

the understanding of glass transition from a solid-state perspective. They discovered two-dimensional melting and were the first to observe octagonal soft quasicrystals in high-density systems of soft-core particles. Using novel biophysics tools, researchers have measured the switching dynamics of flagellar motors, which propel many bacteria. Their results are published in high-profile journals, such as *Physical Review Letters* and *Nature Physics*. ■

High-temperature superconductivity

Superconductors, able to transmit electricity with no energy loss, are sought-after materials in many fields, ranging from information technology to biomedicine. However, the low transition temperature has limited their applications. Breakthroughs by a joint team from USTC and the Institute of Physics (IOP) at CAS have raised the transition temperature considerably, shedding light on more efficient power transmission.

USTC researchers, led by CAS member Chen Xianhui, with their IOP colleagues, have identified a new family of high-temperature superconductors in iron-based materials, which are normally considered poor conductors. They achieved superconductivity at a transition temperature of 55K, raising the critical temperature well above 40K at ambient pressure for the first time. The team also synthesized a series of novel iron-based superconducting materials, including an air-stable iron selenide superconductor.

These achievements won Chen the first prize of the National Natural Science Award in 2013 and the 2015 Bernd T. Matthias Prize for Superconducting Materials.

Micius, developed by Pan's team, is the world's first quantum science satellite.

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ASTRONOMY

The USTC astronomy programme started in 1972 and has grown into a research institution and training base with global impact. In collaboration with the CAS Purple Mountain Observatory, China's cradle of modern astronomy, USTC established a school of astronomy and space science in 2016, cementing the integration of astronomical research and education.

Housing five CAS key laboratories, the USTC astronomy programme worked on the Wukong satellite, the dark matter explorer, and the Ali CMB Polarization Telescope (AliCPT), the first ground-based cosmic microwave background (CMB) project in the northern hemisphere. Its researchers are currently developing a 2.5m wide field survey telescope (WFST). Based on an advanced primary-focus system, the novel optical design will enable the telescope to precisely survey a wide swathe of sky at wide wave bands. The focal plane is equipped with a 0.9 gigapixel mosaic CCD camera, allowing the entire northern hemisphere to be surveyed every three nights.

When completed in 2021, the WFST will be the most advanced of its type in the northern hemisphere, gathering valuable observatory data to monitor astronomical events efficiently. ■

USTC took part in the development of Wukong satellite, China's first dark matter explorer.

USTC geo-scientists joined China's Antarctic and Arctic voyages for polar research.

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GEOSCIENCE

Earth and space sciences are a traditional strength at USTC. Original departments of applied geophysics, geochemistry and rare elements, established at the founding of the university, were integrated into the School of Earth and Space Sciences (SESS) in 2001. The school exploits the brilliance of USTC resources in physics, chemistry and other fields for further development.

Major research areas include space physics, solid geophysics, atmospheric science, geochemistry and environmental science. With advanced research platforms, including CAS key laboratories on the near Earth space environment and on crust-mantle materials and environment, a provincial key laboratory on polar environment and global change, and a wilderness science observation station, the school has made breakthrough results in basic research and applicable technologies. It stands out for research on subduction zones, deep-Earth, the space environment, the polar environment and atmospheric remote sensing. These works have supported developing advanced instruments, such as quantum laser radar and space payload.

As China grows into a research powerhouse, the exploration of deep sea, deep Earth and deep space is on the national strategic agenda. Seizing this priority, SESS is maintaining its leading position by enhancing its strengths, and initiating new programmes in emerging fields.

One such area is comparative planetology, which integrates almost all areas of geoscience. The exploration of planets also has important implications to the future of society. Committed to developing this frontier field, SESS is deeply involved in China's major space research projects, including the missions to explore Mars and the Moon. It has also undertaken the job of building carrying capacity for space shuttles and other exploration infrastructure. ■



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CHEMISTRY & MATERIAL SCIENCE

Chemistry and material sciences are central priorities at USTC. Cutting-edge science and interdisciplinary areas were set as focus from the very beginning.

One feature is the integration of chemistry and physics in the chemical physics department and polymer chemistry and physics department established in 1958. The former was set to meet the demands for talent at the interface between chemistry and physics; while the latter, China's first polymer science department, played a key role in the speedy growth of China's polymer industry of plastic, rubber and fibre.

Now, the USTC School of Chemistry and Materials Science houses three CAS key laboratories, on energy conversion materials, soft matter chemistry, and urban pollutant conversion, as well as two provincial key laboratories of biomass clean energy and functional materials, and two platforms for technology application. The school spearheads the development of single-molecular chemical physics, nanomaterials, as well as organic and soft matter functional materials, with a series of internationally recognized breakthroughs.

A team on single molecular optoelectronics, led by USTC professors, Hou Jianguo, a CAS member, and Dong Zhenchao, developed high spatial resolution optical characterization technology, incorporating a scanning probe technique. It enables single-molecule Raman imaging, producing detailed chemical images with spatial resolution below one nanometre. They also developed super-resolution electroluminescent imaging technology, which allows observing intermolecular dynamics, such as dipole-dipole

coupling. Their research provides new tools for chemical imaging, opening up a new avenue for studying molecular interactions and energy transfer.

Inspired by biomaterials, the biomimetic material group, led by USTC professor Yu Shuhong, has developed fabrication techniques for making bulk artificial mother-of-pearl, very similar to the natural material, with enhanced strength. Biomimetic materials they fabricated also include super elastic and anti-fatigue carbon-based aerogel, and a resin-based porous material that mimics wood and is light-weight, resilient, fire-proof and corrosion resistant. With the team's mass production technologies, Yu hopes to soon use these biomimetic materials in bone transplantation and biomedicine, body shielding, as well as aerospace.

Aiming to control pollution using chemical tools, a team led by USTC professor, Yu Hanqing, focuses on novel techniques for wastewater treatment. Their quantitative in-situ infrared spectroscopy method can test for multiple pollutants by a high-throughput method for microbiome screening. It biologically treats wastewater based on extracellular electron transfer. They have also developed new catalyst materials for degradation of organic pollutants.

In the field of asymmetric homogeneous catalysis, USTC chemist, Gong Liuzhu, and his team have been studying organo- and metal combined asymmetric catalysis since it was first reported in 2001. Integrating cooperative and relay catalysis of organic molecules and metal complexes, they have achieved chemical reactions unattainable by using a single catalyst alone. ■

Hefei National Laboratory for Physical Sciences at the Microscale

The Hefei National Laboratory for Physical Sciences at the Microscale (HFNL) was established at USTC as a pillar in support of building Hefei into a national science centre. This interdisciplinary platform focuses on emerging fields of national strategic importance, such as information science, new energy and health, and leverages USTC's resources in nanotechnology, biotechnology, cognitive science and information technology to support basic and applied research.

With 10 research divisions, HFNL seeks to make original breakthroughs in optical and cold atom physics, single molecular and low-dimensional physics and chemistry, nanomaterials, catalysis and energy conversion, as well as molecular and cell biophysics, neural circuits and brain cognition, molecular medicine and computation science. Its innovative researchers have undertaken numerous national major research projects, ranging from quantum control and quantum information to nanotechnology and protein machines. World-leading results include achieving entanglement swapping with storage and retrieval of light, which clears the way for long-distance quantum communication, and developing novel, iron-based superconducting materials, promoting condensed matter physics research.

With an efficient, novel management system and world-class public technology platforms, equipped with advanced instruments, HFNL is poised to become a first-class centre for basic research, talent training and innovative technologies.

Advances in nanomaterials assist in carbon recycle

A USTC research team has established techniques for fabricating ultra-thin two-dimensional (2D) materials that may be used in novel energy materials to curb carbon emission.

Based on revealing the unique electronic state and the precise structural characterization of these materials, the team, led by CAS member, Xie Yi, constructed highly active and stable hybrid systems for 2D ultrathin materials. They also showed how the oxides on the pristine metal surface influence its electroreduction of CO₂, shedding light on 2D nanomaterials as promising catalysts for converting CO₂ into useful fuels. Their work, published in *Nature*, contributed to the development of sustainable carbon economy and was selected as one of the top 10 major scientific advances of the year in China.

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ENGINEERING REAL-WORLD SOLUTIONS



Hsue-Shen Tsien, the former Caltech professor who directed the Jet Propulsion Laboratory, helped found the USTC mechanics programme.

For researchers in the engineering science and mechanics programmes at the University of Science and Technology of China (USTC), there is no question too complex or too small in their quest for answers with real-world impact. They are examining everything from the flow of arterial blood, to lasers for 3D printing. This multidisciplinary programme is expanding its core work in engineering mechanics and precision instruments to encompass a wider scope that includes new energy, safety, and other emerging engineering technologies.

For example, research in precision machinery and instrument uses mechanical, optical, electrical and automatic controls and integrate computer science to develop robots, micro- and nano-electromechanical

systems, and photoelectric information technologies. At the micro-nano engineering laboratory, led by Chu Jiaru, scientists are developing 3D micro- or nano-processing technologies based on the study of femtosecond lasers. The lab also works on ultrafast laser technologies, which are useful for high-efficiency additive manufacturing tools, such as 3D printers, while others work on nanostructure self-assembly, laser fabrication of functional surfaces, liquid-phase atomic force microscopy and precision printing. Green manufacturing, renewable energy and biomedical engineering also stand to benefit from the lab's nano-measurement technology (based on the use of scanning probe microscopy) and novel micro- or nano-measurement methods.

Bring in the mechanics

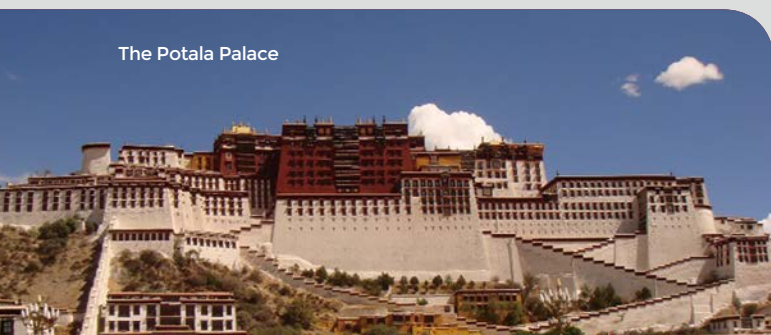
The USTC mechanics programme started from the Department of Modern Mechanics, established in 1958 by the prominent Chinese rocket scientist, Hsue-Shen Tsien. It addresses problems in space science, energy, transport, national defence, and equipment engineering by harnessing technologies ranging from fluid, solid, and engineering mechanics to biomechanics.

The NSFC Innovative Research Group led by Lu Xiyun, for instance, is focused on fluid dynamics within vortexes, interfaces and blast waves. The team is also looking into what we can learn from the dynamics of swimming fish, birds and insects, arterial blood and microcirculation, with the latter potentially finding use in the design of microfluidic devices.

The CAS Key Laboratory of Mechanical Behavior and Design of Materials, led by Wu Hengan, is devoted to material design, fabrication and application. By understanding the quantitative relationships between micro and macro, they seek to better control the microstructures of materials to achieve optimal macro-mechanical behaviours. The laboratory has recently discovered the mechanism behind the fast water transport in atomic-precision capillaries. The permeation properties of these graphene nanocapillaries are controllable, shedding light on nanofluidic systems design. Another of their studies reported proton transport through two-dimensional crystals, such as graphene, suggesting these materials will prove useful, for example, as proton membranes for hydrogen fuel cell technologies.

The energy engineering programme at USTC seeks to solve key problems in solar energy conversion, storage and transmission. Researchers at the CAS Research Center of Solar Thermal Conversion, led by Ji Jie, are working on: the architectural integration of solar energy; the use of solar photothermal and photovoltaic energy; concentrating sunlight to produce heat for electricity generation; and providing technological support to scaled-up use of solar thermal systems. Researchers also work on combustion theories, heat transfer and conversion, energy saving and emission control, as well as biomass energy conversion and use. ■

The Potala Palace



Taking the heat

The State Key Laboratory of Fire Science at USTC seeks to address national fire safety needs by studying prevention and control technologies. Led by Zhang Heping, researchers are studying the evolution and the complex dynamics of fires to develop effective techniques for prevention and protection, fire security engineering, and emergency evacuation methods.

Their green fire retardant, smart detection and clean agent fire extinguishing technologies are used in safety management in significant buildings, such as the historical Potala Palace, as well as in skyscrapers, underground spaces, airplanes, ships and major engineering sites. Their work plays a significant role in national security and disaster management.

THE FACE OF SMART TECHNOLOGIES

Jiajia the robot can respond to facial expressions in conversations.

The Chinese robot Jiajia blinked and moved her head in response to questions thrown her way during face-to-face dialogs with media and users in 2016.

Able to respond to facial expressions with her own micro-level movements during conversations in both Chinese and English, Jiajia is the result of integrating technologies for cognitive modelling, semantic understanding, automated reasoning and planning, knowledge acquisition, kinematics and cloud robotics. These technologies have been studied in the Kejia Robotics project by Chen Xiaoping's laboratory at USTC. The award-winning development team has received many international accolades, including first places at the popular RoboCup world championship, and the IJCAI Robotics competition.

The Jiajia project is just one aspect of the computer science and information engineering programmes at USTC, which use high-performance computing to develop intelligent technologies. Another group is working on a 'smart bed' to monitor motion and vital signs at the Laboratory for Intelligent Networking and Knowledge Engineering, led by Li Xiangyang.

His lab is also developing a wireless charging approach to transmit energy over tens of metres to moving battery-less devices. Their battery-free sensor network (BFSN), mainly harvesting energy from ambient environment, is being designed to service the large-scale needs of the Internet of Things (IoT) in smart sensing, communicating and computing.

Li's lab also covers intelligent sensing, IoT security, edge computing, and data privacy and exchange. Zhang Xinming complements this with work on performance optimization for IoT

devices, and routing algorithms to enhance the performance of wireless ad hoc networks.

Many others at USTC are also working on cutting-edge computing issues. Tian Ye has modelled the topology and geolocation of the Chinese internet network.

Meanwhile, to address increasing network security challenges, Xiong Yan and Huang Wenchao lead a team that has developed a world-first strategy to automatically verify network protocols for checking design flaws and security weaknesses, reducing the risk of costly technological failures.

Chen Enhong's team develops data-driven intelligent services for a wide range of fields, including context-aware data mining, internet finance and intelligent education. Their Fuzzy Cognitive Diagnosis Framework can precisely analyse students' cognitive knowledge mastery for personalized education solutions. They have also combined hierarchical time series and transformation regression approaches, enabling dynamic tracking and prediction of projects on crowdfunding platforms.

These advances in computer science are backed by the National High Performance Computing Center in Hefei, which was founded in 1995. The first of its kind in China, the centre is a node in China's national grid computing network and promotes the country's high-performance computing industry.

Led by CAS members Chen Guoliang and Shi Zhongci, the centre has been behind projects on weather prediction, bridge mechanics, electric power use, big data real-time analysis and other basic research, leading to more than 20 awards and 1,000-plus journal publications. ■



Straight to the source for artificial intelligence research

The National Engineering Laboratory for Brain-inspired Intelligence Technology and Application was established in 2017 to address the rapid development of artificial intelligence (AI). The only national-level research platform in the field, it aims to establish an innovation system that integrates research, education, and industrial applications.

The laboratory has five research priorities, one of which is natural language processing. Its researchers seek to improve machine translation via research on acoustic modelling, syntax understanding, conversation generation, emotion analyses and knowledge reasoning. Inspired by advances in the understanding of the human visual system, researchers in

graphic and video processing want to develop technologies for information presentation and human-machine interaction, covering everything from graphic acquisition and perception to analysis and indexing.

The laboratory also seeks to understand how best to provide a secure and efficient intelligent service framework. On the hardware front, research on high density brain-inspired chips aims to simulate the large-scale asynchronous parallel information processing of the human brain. Using autonomous machine learning and control theory, researchers are also devoted to developing general-purpose, human-like robots capable of decision-making and high-precision movements.

EMBRACING NEW MEDICINE

To forge ahead in biological and biomedical science at the University of Science and Technology of China (USTC), in 2017, a brand new Faculty of Life Sciences and Medicine was established. It includes the School of Life Sciences and the newly merged USTC's first affiliated hospital, the former Anhui Provincial Hospital, which is an impressive 5,000-plus bed facility treating 3.7 million outpatients every year. Tackling a wave of 'New Medicine' is the focus of this fresh interdisciplinary initiative at USTC.

Before the merger, USTC's School of Life Sciences was already ranked by the Chinese Ministry of Education among the nation's top five for its education and biological science research programmes. It was in the global top 1% in Essential Science Indicators (ESI) rankings for biology and biochemistry, environment/ecology, molecular biology & genetics, plant and animal science and clinical medicine.

Research at the school had traditionally been centered around interdisciplinary biological and biomedical sciences, which include biochemistry, molecular biology, cell biology, immunology, neuroscience, biophysics, genetics and genomics, bioinformatics, reproduction science, synthetic biology, molecular plant and biomaterials.

The genesis for this success dates back to 1958, when the Department of Biophysics was founded by renowned biologist, Bei Shizhang, famed for his ground-breaking research on radiobiology, cytology and embryology. The department was then expanded to establish the School of Life Sciences in 1998 by Chinese Academy of Sciences (CAS) member, Shi Yunyu.

In collaboration with several CAS institutes, the School of Life Sciences has launched undergraduate and postgraduate programmes that explore new models for higher education. Many of the school's alumni have taken leadership roles in

Renowned biologist, Bei Shizhang, was a founding father of biophysics at USTC.

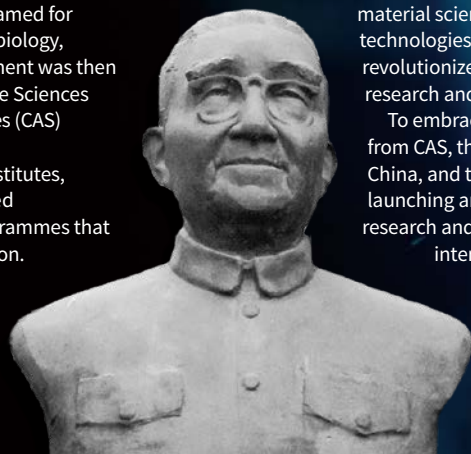
domestic and international academic communities, including six achieving CAS membership.

The school was made up of four departments: the Department of Molecular and Cell Biology; the Department of Biophysics and Neuroscience; the Department of System Biology; and the Department of Medical Biotechnology. It houses three research divisions of the National Laboratory for Physical Sciences at the Microscale and three CAS key laboratories. Its state-of-the-art core facilities for biological and biomedical research include one equipped with a network-based information intelligent management system.

Rapid technological advancement brings significant opportunity to improve conventional medicine. Researchers strive for better solutions using cutting-edge physical and chemical technologies, artificial intelligence and big data, computational modelling of complex biological systems, and new material science technology.

USTC's Faculty of Life Sciences and Medicine is exploring the field of 'New Medicine', combining material sciences, engineering and informatics technologies with conventional medicine to revolutionize contemporary medical education, research and practice.

To embrace these opportunities, with support from CAS, the National Health Commission of China, and the Anhui Province government, USTC is launching an initiative to create medical education, research and healthcare hubs. The aim is to combine interdisciplinary approaches to transform conventional medicine and education. ■



Expanding medical excellence

THE FIRST AFFILIATED HOSPITAL OF USTC, was founded in 1898 as Hefei Christian Hospital. A large general hospital with the top ranking (3A) in China, it is the largest in Anhui province and ranks in China's top ten in the number of beds. It is the pinnacle of medical and health development in Anhui, encompassing 69 network hospitals.

With advanced equipment, a comprehensive spread of departments, and cutting-edge techniques, the hospital provides medical service, education, research, rehabilitation, first-aid services, and public health prevention.

The hospital is now expanding into a larger complex, containing a headquarters (Anhui Provincial Hospital), Anhui Provincial Cardio-cerebro-vascular Hospital (the South Block), Anhui Provincial Tumor Hospital (the West Block), an Infectious Diseases Hospital, and a Medical Center of Minimally Invasive Surgery. The North Block and the Geriatric Medical Treatment & Rehabilitation Center are under construction.



The USTC hospital is quickly expanding, becoming a comprehensive and modern enterprise.

A new home for big data and artificial intelligence

AS SEQUENCING AND OTHER HIGH-THROUGHPUT TECHNOLOGIES IMPROVE, data is generated at an increasingly fast pace, driving biomedicine into an era of big data and personalized 'omics'.

In response, USTC is building the Center for Medical Big data and Artificial intelligence (CMBA), which integrates genomics, bioinformatics, immunology, neurosciences, mathematics and computer science to develop novel experimental and computational methods to dissect and integrate large-scale personal medical information. The research will provide insights for precise diagnosis and therapeutics for cancer and other major diseases. The Faculty of Life Sciences and Medicine has 15 principal

investigators working in this field, recruited from top research institutes around the world, and plans to extend this to around 50.

Currently under construction, the centre will have five main platforms: a bioinformatics platform with state-of-the-art supercomputing hardware and software; a novel technology research platform developing the most advanced imaging, sequencing (particularly of single cells) and biomedical engineering technologies; a platform for clinical sample collection, preparation and preservation; a genomic sequencing platform for clinical library constructing, quality control and data generation; and an artificial intelligence research centre.

The new faculty is equipped with a public platform for life sciences research.



LIGHTING THE WAY FOR TOMORROW

Significant scientific progress is increasingly the result of national or international collaboration. A particular strength of the University of Science and Technology of China (USTC) is its powerful facilities designed specifically to cater for large-scale science, which will help form the bedrock of China's second Comprehensive National Science Center, based in Hefei.

Accelerating research with the Hefei Light Source

USTC has proven expertise in major national projects. With USTC's support, China's synchrotron radiation accelerator was officially launched in 1983, becoming the country's first dedicated VUV and soft X-ray synchrotron radiation facility — the Hefei Light Source (HLS).

To better serve growing demand, phase II of the HLS (HLS-II) was launched in 2010. In this phase a linear accelerator, an 800MeV storage ring and five beamline stations were built, all of which, plus the top-off operation mode, have significantly improved the stability, brightness and service life of the light source.

Opened for use in 2016, HLS-II has been used in 889 projects, leading to 700-plus journal publications. The facility drives international collaborations and quality research in material science, condensed matter physics, chemistry, energy, environmental science and life sciences.

Now under the R&D plan is the Hefei Advanced Light Source, proposed by Lu Yalin, who heads the National Synchrotron Radiation Laboratory. This new effort will integrate advanced measurement technology, leading to one of the most advanced synchrotron radiation light sources in the world, with ultrahigh temporal, spatial and energy resolution.

Nuclear fusion energy: The Experimental Advanced Superconducting Tokamak

Providing safe and clean nuclear fusion energy to ward off future energy crises is a global challenge. Led by the CAS Institute of Plasma Physics (IPP), USTC and IPP have built the world's first fully superconducting tokamak, a doughnut-shaped, magnetic confinement device, designed to better harness fusion energy.

An experimental machine designed to explore the physics and engineering of nuclear fusion reactions, the Experimental Advanced Superconducting Tokamak (EAST) uses superconducting magnets to

confine hot plasma. Its maximum repeatable plasma current can reach 1MA, currently the highest in the world, while its diverted plasma discharge is the world's longest.

In 2017, EAST achieved more than 100 seconds of steady-state, high-confinement mode (H-mode) operation, a world record. This has implications for the International Thermonuclear Experimental Reactor (ITER), a huge international effort, in which China is a participant, aiming to build the infrastructure to provide clean nuclear fusion power.

International collaborations through EAST have already included a joint experiment on steady-state operation with the DIII-D team of defence contractor General Atomics in the United States, joint conferences and projects on plasma-wall interactions with Germany, and joint efforts with Russia to translate research results.

More fusion power: Keda Torus eXperiment

Another device harnessing fusion power is USTC's Keda Torus eXperiment (KTX), a medium-sized reversed field pinch (RFP) that is smaller and more economical than a tokamak, producing a magnetic field through currents flowing inside plasma.

Completed in 2015, KTX supports three-dimensional toroidal physics research and improves plasma control technologies. It pioneered the eddy current diagnostics to measure plasma displacement, and used novel design to cut down the cost of vacuum vessel maintenance. With a maximum plasma discharge time of 22ms, KTX has been widely utilized, winning acclaim from 30-plus leading interactional experts on magnetic confinement configuration.

Steady High Magnetic Field Facilities

The Steady High Magnetic Field Facility (SHMFF) that USTC participated in building includes a hybrid magnet, five water-cooled magnets and four superconducting magnets, enabling extreme low-temperature and high-pressure experiments for cutting-edge research in a range of fields. It features the world's first three-in-one microscope system, combining scanning tunnelling, magnetic force and atomic force microscopes. Three of its water-cooled magnets have set world records in performance and the 40-tesla-level hybrid magnet has the world's second highest magnetic field. SHMFF has so far been used by 120-plus institutions and for more than 1,100 papers. ■

CULTIVATING INNOVATORS THROUGH A TAILORED EDUCATION

During the 2016 commencement ceremony at Harvard University, one man was the focus of much attention. He Jiang, then a doctoral student in biochemistry, became the first Chinese citizen ever to give a commencement speech at the historic Ivy League institution.

Six years ago, He graduated from the University of Science and Technology of China (USTC). A boy from a village in central China, He's path to discovery — using single-virus tracking, super-resolution imaging (STORM) to understand more about how influenza infects cells — started at USTC.

Since its founding in 1958, USTC has been dedicated to building a bespoke education, and its efforts are paying off. During its 60-year history, the university has produced 49 members of the Chinese Academy of Sciences (CAS) and 23 members of the Chinese Academy of Engineering (CAE), and is first in the country for its percentage of CAS/CAE member alumni.

Notable alumni also include Pan Jianwei, known as Father of Quantum in China; Xie Yi, who works in inorganic functional nanomaterials and nanostructures and became the youngest female to be selected as a CAS member; and Deng Zhonghan, the youngest person to be selected as a CAE member, a world renowned leader in electrical engineering and physics.

USTC alumni have built international reputations, with nearly a third of its undergraduates receiving scholarships to study at world-class universities after graduation. Many come back to undertake research in China. By the end of 2017, 10% of returnees on the 'One Thousand Young Talents' programme were USTC graduates.

USTC's programmes aim to provide an integrative and international education. Students get hands-on research experience at institutes in China and abroad.

To better direct a student's potential, USTC has also launched reforms in curriculum planning, and major and career guidance. Students have the flexibility to choose and change their majors.

Ties with the Chinese Academy of Sciences (CAS) have also enabled USTC to leverage CAS resources and to integrate CAS institutes and USTC departments. Since 2009, USTC has launched 14 talent programmes in collaboration with various CAS institutes, such as the Academy of Mathematics and Systems Science and the Institute of Physics.

By sharing CAS and USTC resources and finding ways to work in tandem, these joint programmes provide optimal learning and research practice opportunities to students. The talent programmes have also become sites for piloting new curricula, educational models and talent selection mechanisms. ■

Nurturing brilliance

The School of the Gifted Young

In 1974, Tsung-Dao Lee, a Nobel laureate in physics, came up with a novel idea.

He presented the country's leadership with a proposal to provide higher education for the most academically gifted of China's youth. Four years later, a designated class for gifted young people was launched at USTC.

This programme evolved to become the School of the Gifted Young (SGY), which provides an undergraduate education to those too young to be admitted to universities.

Its education includes cross-disciplinary training, a flexible schooling system and personalized course planning. SGY alumni active in the science and technology arena include Zhuang Xiaowei, the youngest foreign member of CAS, and Zhang Yaqin, president of Baidu, China's online search engine giant.

He Jiang, was the first Chinese citizen ever to address the commencement ceremony at Harvard University, when he graduated in 2016.





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