South China: A rising power in science


Guangzhou city on the Pearl River

After emerging as a trade superpower, China aims to become a leading force in scientific research and applications ranging from cosmology and spaceflight to genomics and medicine. Universities across south China are stepping up the recruitment of scientists with advanced degrees gained in Europe or the United States. This strategy has yielded prestigious science prizes and papers, and generated the growth of scientific research clusters in the region.
By Kevin Holden

When China's leaders decided a generation ago to experiment with opening the People's Republic to global market forces, they created an archipelago of special economic zones (SEZs) along the nation's southern coast. South China's resulting transformation into an export powerhouse has helped make the country a world trade titan. Now the region is part of a new round of reforms aimed at reshaping China into a globally connected pioneer in the sciences.

China's universities, along with the National Natural Science Foundation and the Chinese Academy of Sciences (CAS), have created award schemes aimed at attracting scientists trained in the United States or Europe to take positions across southern China and to help spur the next stage of the region's metamorphosis. These strategies are helping power research breakthroughs in the spheres of space science, physics, genomics, and medicine.

From rice paddies to space stations

The drive to transmute the country's burgeoning economic might into scientific prowess is evident across southern China. Shenzhen, crisscrossed by rice paddies when it was designated an SEZ, is now one of the world's fastest growing cities and hosts one of China's leading genomics outfits. Similarly, the tropical island of Hainan, ringed by fishing villages when it too became an SEZ, opened its new space launch center this summer. Thousands of visitors watched the premier liftoff of the new Long March 7 rocket, along with the prototype of a next-generation human space capsule that it carried into orbit.

CAS leaders say spaceflight is a high-priority sector for heightened international cooperation. China recently signed an agreement with the United Nations Office for Outer Space Affairs, outlining Beijing's pledge "to enable United Nations member states, particularly developing countries, to conduct space experiments onboard China's space station, as well as to provide flight opportunities for astronauts and payload engineers."

CAS is stepping up its twin drives to boost collaboration on transborder science projects and to increase its standing in worldwide science. One area in which it has made headway is in studies encompassing the formation of the universe, the earliest galaxies, and the solar system.

Planetary scientist **Yuan Li,** a postdoctoral researcher at Rice University in Houston, says he was persuaded to accept a position at the CAS Guangzhou Institute of Geochemistry through a Global Youth Experts award. Li is the lead author of a recent *Nature Geoscience* study, cowritten with colleagues at Rice, which posited that the life-enabling carbon in the Earth's crust might be the result of a collision between the proto-Earth and a Mercury-like planet about 4.4 billion years ago. That collision was distinct from the interplanetary smashup that scientists believe gave birth to the Moon during the early formation of the solar system.

Yuan Li

"During the accretion of our Earth, there were probably numerous collisions between the proto-Earth and small planetary embryos," says Li. This early period in the solar system's evolution, he adds, might have resembled a massive billiards game involving the inner protoplanets crashing into each other before entering stabilized orbits around the sun.

Li's paper is part of a steady rise of articles written by Chinese scholars and published in the world's leading academic journals. He says China's expanding constellation cont.>

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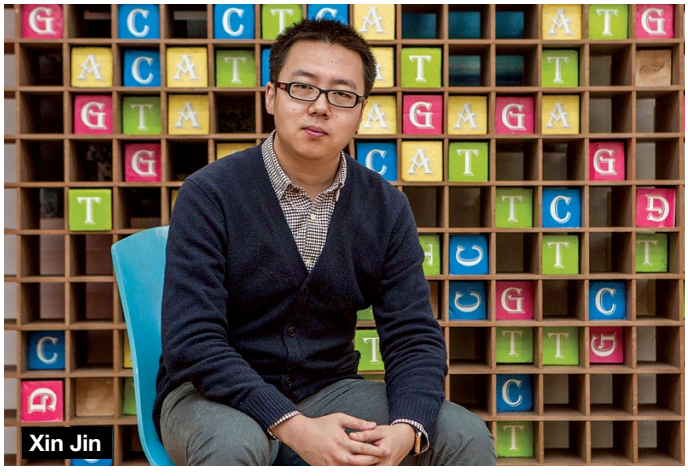
"Shenzhen has repositioned itself as one of the world's leading centers for genetics research."
—Bicheng Yang


Xin Jin

of incentives for scientists is a powerful attraction for scholars trained in the West. "In the past five years, thousands of young scientists like me have returned to China," he says.

Particle physics breakthroughs

China is interested not only in the macroworld, it is also keen on the microworld. Scientists with an advanced degree in physics who have accepted positions at south China universities are helping track and explain how neutrinos morph into different types, or generations, as they fly through space at nearly the speed of light.

These physicists have joined an international team of scientists who are studying nuclear reactor–produced neutrinos in the southern Chinese seaside resort of Daya Bay. Collaboration on these experiments involves universities and physicists stretching across four continents, says **Kam-Biu Luk,** a professor of physics at the University of California, Berkeley, and a distinguished visiting scholar at the University of Hong Kong.

Luk, who heads the international participation in the project, says this exploration of the long-shrouded world of neutrinos is one of the most outstanding experiments in particle physics ever conducted by joint groups of universities based in China and the United States. Physicists at the University of Hong Kong, the Chinese University of Hong Kong, Shenzhen University, Dongguan University of Technology, and Sun Yat-sen University have joined counterparts at Yale, Princeton, and other laboratories in this expanding experiment.

Chinese scientists involved in these neutrino observations, along with the international team headed by Luk, were awarded the prestigious Breakthrough Prize in Fundamental Physics in 2016, for outlining how neutrinos transform as they speed through the cosmos. They won, according to the prize citation, for "revealing a new frontier beyond, and possibly far beyond, the standard model of particle physics."

Due to the rapidly growing neutrino physics programs in China, **Jiajie Ling,** a postdoctoral researcher at the University of Illinois who is now a professor in physics at Sun Yat-sen University, opted to take a position there with start-up funding support from the Thousand Talents Program for Distinguished Young Scholars. He is helping to guide a new series of experiments at Daya Bay: the search for the hypothesized "sterile neutrino." This proposed fourth type of neutrino could be a form of the elusive dark matter that scientists have been searching for since the last century, says Ling.

Future home of particle colliders

According to Ling, the massive neutrino study he is working on is helping China move closer to realizing its plans to host an international coalition of elite physicists around its proposed supercollider projects. China's top-echelon physicists, in tandem with leading scientists worldwide, are designing a ringed particle smasher measuring up to 100 kilometers in circumference that would initially be configured as an electron–positron collider, and would later also host a proton–proton accelerator.

"After so many years of preparation and joining worldwide experiments, now is a fantastic time for China to host the Circular Electron–Positron Collider and the Super Proton–Proton Collider," Ling says. "More importantly, it is also China's responsibility to contribute to advancing high-energy physics and humanity's knowledge about the universe."

Jie Gao, one of the leaders of the twin circular collider projects at the CAS Institute of High Energy Physics, says southern Guangdong Province is a leading contender to host the ringed accelerators. Chinese and American scientists who are laying the groundwork for what would be the largest and most sophisticated particle physics lab in history predict it could attract thousands of the world's experimental physicists to take up positions in China's planned "collider city."

Alain Blondel, one of the primary shapers of the Future Circular Collider being mapped out by CERN (the European Organization for Nuclear Research) in Switzerland, says "it would be fantastic" if the leaders of CERN and of the Chinese supercollider program wind up competing to attract the globe's foremost physicists.

Tao Liu, a physicist at Hong Kong University of Science and Technology, echoes this sentiment. He says China's planned collider project is the most exciting ever to capture the attention of leading physics professors and science students across Hong Kong.

The supercolliders, Liu adds, will "boost development in science and society in the coming decades, [and] will inspire young talents of this and future generations to devote themselves to the exploration of basic science."

PHOTOS: (FROM TOP) BGI; COURTESY OF XIN JIN

Mining the genome

Just across the border from Hong Kong, universities and the local government in Shenzhen are channeling their expanding funds into making globally recognized advances in life science research and applications.

"Shenzhen has repositioned itself as one of the world's leading centers for genetics research," says **Bicheng Yang,** communications director at the genomics outfit BGI, which is moving forward with plans to create a specialized life science college in partnership with the South China University of Technology (SCUT) and the University of Copenhagen.

Four years ago, BGI signed a cooperation pact with the Gates Foundation to set up joint training programs with the University of the Chinese Academy of Sciences and SCUT. "The aim is to integrate the new college more and more into scientific research that stretches across the continents," she explains.

Xin Jin, a genomics expert with dual research positions at BGI and at the SCUT, says, "One of the most exciting projects we are working on is the Chinese Million-ome Project, aimed at decoding one million Chinese genomes across the entire country."

The university and BGI are also exploring the use of genomics to map the genetic evolution of current populations dating back to the early modern humans who trekked to Asia more than 40,000 years ago, and their admixture with more archaic species, adds Jin, who coauthored a study on this topic published in *Nature.*

At the frontier of human genome editing

The potential use of genomic engineering to eradicate the genetic bases for diseases is also being explored by groups of university researchers in the southern mega-city of Guangzhou. One of these groups recently reported conducting a leading-edge experiment, but with only limited success, in editing the genomes of human embryos to confer genetic resistance to HIV infections. A similar paper published in 2015 by researchers at Sun Yat-sen University ignited a global debate over whether this type of research should be conducted on human embryos because of its potential to trigger genetic changes that ripple across future generations.

Since then, leaders of the national science academies in the United States, the United Kingdom, and China have met and reached a consensus that while this type of research could continue, any applications should be prohibited. The lead organizer of the summit involving the three science academies was **David Baltimore,** president emeritus of the California Institute of Technology. He adds that Chinese researchers can move forward with embryonic genome editing studies as long as "experiments are limited to 14 days of in vitro growth and no implantation is attempted."

The genomics teams at Sun Yat-sen University and at Guangzhou Medical University, says Baltimore, represent "an effort of two labs to move into the forefront of the research."

Some scholars suggest that China's support for these studies, in view of the U.S. Congressional ban on federal funding for research involving modifying the genomes of human embryos, could help scientists across Chinese universities move ahead in this realm of gene editing.

FEATURED PARTICIPANTS

BGI
www.bgi.com/us

California Institute of Technology
www.caltech.edu

CERN Future Circular Collider Study
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Reversing "brain drain"

In another region of south China, at the Guangdong University of Foreign Studies, **Jing Yang** has been conducting research with colleagues at Pennsylvania State University on structural changes in the brain that occur when students begin studying a second language.

Yang, formerly a postdoctoral fellow at Penn State, says she joined Guangdong University of Foreign Studies because the school "is well known for cultivating international talent." She says she aims to help transform the university's language center into "a leading research center for linguistics and applied linguistics," and adds that the government is providing large-scale grant support to reach that goal.

China's economic ascent and the increasingly attractive recruitment packages offered by its universities are becoming extremely appealing to Chinese scholars who have studied in the West, Yang says, and are beginning to help reverse a decades-long brain drain, during which scholars left the country to pursue their careers elsewhere.

While many Chinese scientists still opt to stay in Europe or the United States after obtaining an advanced degree there, Yang observes that "some scholars, like me, chose to go home to work for a brighter future for ourselves and also for our country." These scholars, she adds, are helping create clusters of excellent scientific research across China.

"The rise of China definitely is not limited to the economy," Yang explains. "We hope our country can excel in science, culture, and technology too. It is a double win for China and the world."

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DOI: 10.1126/science.opms.r1600172