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LEAD ARTICLE

President Xi Jinping meets space scientists and engineers involved in the research and development of the Chang'e 4 lunar mission in the Great Hall of the People in Beijing on Feb 20. [IMAGE FROM XINHUA]

President Xi meets space scientists and engineers of Chang'e 4 lunar mission

President Xi Jinping on Feb 20 urged China's science and technology professionals to uphold innovation and strive to improve the nation's capability in the sector.

When meeting with representatives from the Chang'e 4 lunar exploration program in Beijing, Xi, also general secretary of the Communist Party of China Central Committee and chairman of the Central Military Commission, said the Chang'e 4 mission embodies Chinese researchers' innovative endeavors, and innovation is crucial to China's efforts to become a strong power in science and technology.

The president instructed researchers to focus on strategic, fundamental and cutting-edge fields, catch up with front-runners and set long-term goals. He also encouraged them to strive for breakthroughs in key technology sectors and boost China's research and innovation capabilities so the nation can gain a key place in the global high-tech arena.

Xi thanked China's space industry workers for their outstanding contributions to space exploration and also for inspiring the Chinese people in their path toward the great national rejuvenation.

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Chinese quantum physics team honored

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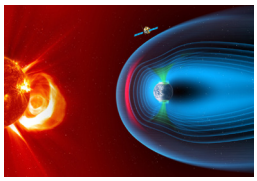
ESA gives go-ahead for SMILE mission with China



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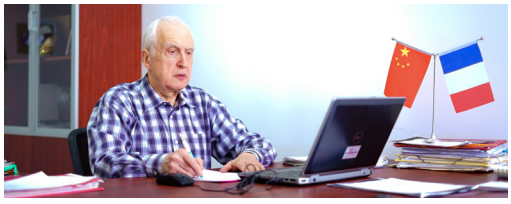
An applied mathematician's life in China



In September, 2017, I departed Xiamen University as I had received an invitation from Professor Liang Xing to join the School of Mathematical Sciences of the University of Science and Technology of China (USTC) as a long-term visiting professor. >> PAGE 8

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American, Chinese scientists call for international collaboration in scientific research

American and Chinese scientists have called for international collaboration in scientific research at the ongoing annual meeting of the American Association for the Advancement of Science (AAAS) to build more trust between the two countries.

The call came after a Chinese elementary particle and accelerator physicist staged a roadshow for China's megascience projects in high energy physics at a seminar.

Wang Yifang, director of the Institute of High Energy Physics (IHEP) of the Chinese Academy of Sciences, reviewed how China and the United States worked together to complete a neutrino experiment at China's Daya Bay Reactor and envisioned having more such cooperation in a cosmic ray observatory project called LHAASO and a more ambitious circular collider in the pipeline.

"Actually, in the past 30 years, no large-scale high-energy physics project was done by one country," Wang told Xinhua. "And now it is the time for newly developed emerging countries to contribute more to science."

Wang was echoed by Caroline Wagner, a science policy expert at Ohio State University. Wagner said that "openness" is critical for basic science research and the key to it is "to share," at all levels.

International collaboration is a major topic at this year's AAAS meeting which has a theme of "Science Transcending Boundaries." The theme is set against looming challenges for international scientific partnership.

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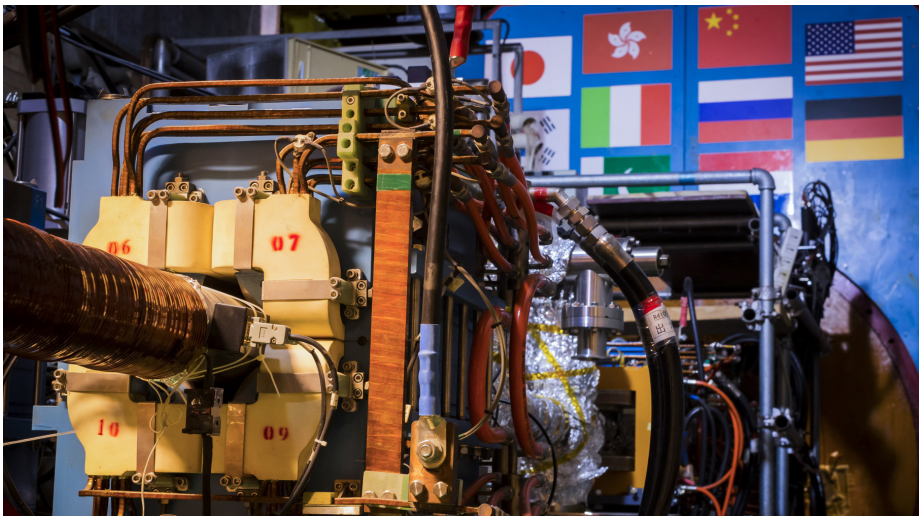

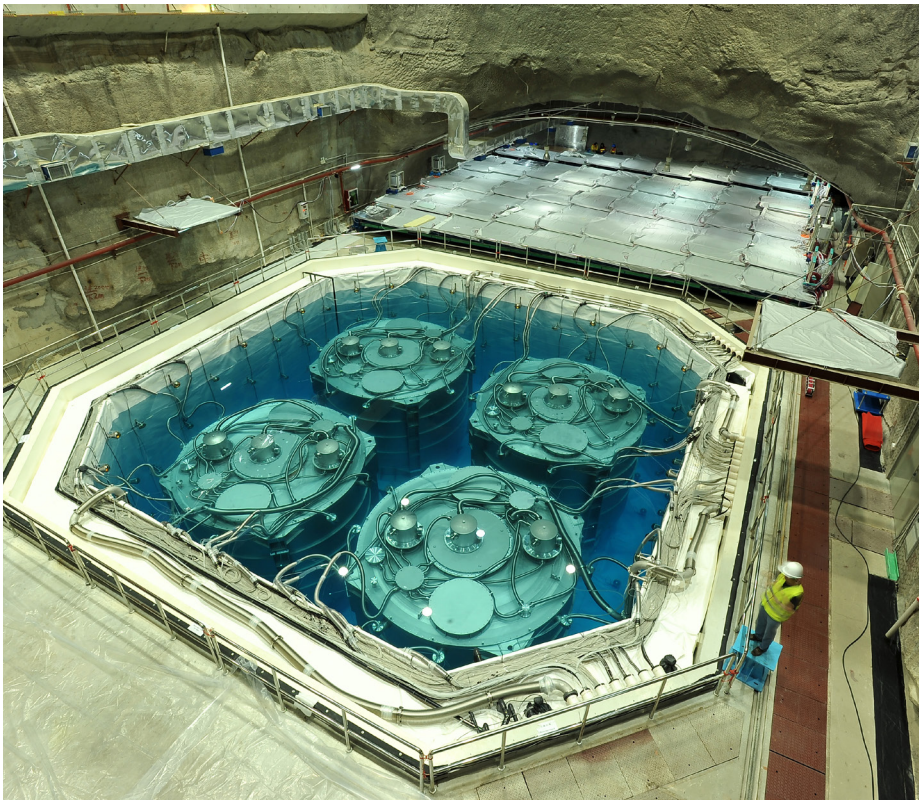

The Daya Bay Experiment is a neutrino-oscillation experiment designed to measure the mixing angle θ13 using antineutrinos produced by reactors of the Daya Bay and Ling Ao nuclear power plants. [IMAGE BY IHEP]

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Peter Michelson, a Stanford physicist, attributed the challenges to an era of renewed nationalism and anti-globalization and a loss of ground by evidence-based research.

"The best collaborators may be in other countries, and former graduate students and postdocs are potential collaborators," said Michelson.

However, a memo released by the U.S. Department of Energy (DOE) last November restricted DOE-funded researchers working in "emerging research areas and technologies" from collaborating with colleagues from unspecified "sensitive" countries, which may block many foreign research cooperation projects and cast shadows on others.

Ali Khounsary, a research professor of physics at the Illinois Institute of Technology, lodged his objection at the seminar, saying choosing collaborators by their citizenship is "unbelievable."

"Cooperation in basic science should be immunized from politics and developed in a global way since we have common interests, common benefits and risks, common tools and methods and common issues," said Wang.

Michelson told Xinhua that strong international partnership will become more important for future scientific progress as science facilities come with increasing size, complexity and cost.

Michelson took delight in talking about a collaboration between China and the United States that led to the first discovery of a millisecond pulsar.

In April last year, China's Five-hundred-meter Aperture Spherical radio Telescope (FAST) discovered a radio millisecond pulsar coincident with the unassociated gamma-ray source in the Fermi Large Area Telescope (LAT) point-source list.

More than one-third of the Daya Bay Reactor neutrino experiment's investment and researchers came from the United States, according to Wang.

Scientists at the meeting do not consider international collaboration to conflict with international competition.

Jonathan Adams, an analyst at Philadelphia-based Clarivate Analytics, told Xinhua that the top institutions, which are the major players in scientific research, "need to recruit talent globally" to gain their leadership.

Wang said that the competition between different groups and projects is an incentive for progress in science, but within a group or a project, researchers with diversified backgrounds can produce better results, or, in Michelson's words, "collaborate to compete."

U.S. institutional authors collaborate most frequently with authors from China, currently the largest producer of publications. China accounted for 22.9 percent of U.S. internationally coauthored publications in 2016, according to the latest science and engineering indicator released by the U.S. National Science Board.

Some Americans are skeptical about U.S.-China cooperation, partly due to lack of trust, said Wagner, but "we should collaborate to build trust," "rather than stop it until we have trust."

AAAS is the world's largest general scientific society and its annual meetings promote communication between policymakers, researchers and the general public.

Source: Xinhua

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"There is no end to space exploration. Our science, technology and space workers shall move forward toward the next goals in our lunar program and shall also continue working hard for advances in the world's space undertakings," he said.

Xi said great accomplishments start with dreams, rely on innovation and are fulfilled through hard work.

He said the aim of China's lunar program is to fulfill the Chinese nation's long-held dream of embracing the moon, and he encouraged every industry and every person in China to cherish their dreams and make relentless, generational efforts to realize them.

Xi also said China is willing to work with other nations to foster international communication and cooperation in science.

Chang'e 4 was launched atop a Long March 3B rocket in December last year at the Xichang Satellite Launch Center in Sichuan province in the country's fourth lunar exploration and the world's first expedition of the moon's far side.

The robotic probe made a soft landing there on Jan 3 and then released Yutu 2, the world's seventh rover on the moon and the first on the far side, to roam and survey the landing site in the South Pole -- the Aitken basin, the largest and deepest known basin in the solar system.

Yutu 2 has moved nearly 120 meters across the lunar surface and is in its second dormancy as the moon's far side goes through a 14-day lunar night. It is expected to be reactivated next week.

The Chang'e 5 probe is scheduled to be sent to the moon around the end of 2019. It will collect lunar samples and bring them back to Earth. If the Chang'e 5 mission succeeds, China will become the third nation to retrieve lunar samples after the United States and Russia.

Source: China Daily

Chinese quantum physics team honored

Pan Jianwei, a Chinese quantum physicist, led a team that used a satellite to send photon pairs through the near vacuum of space, successfully measuring the quantum keys at Tibetan receiving stations 1,203 kilometers apart.

The research, "Satellite-based entanglement distribution over 1200 kilometers", was published in *Science*, a leading journal on scientific research, on June 16, 2017.

It was selected for the Newcomb-Cleveland prize for the most impactful paper published in *Science* magazine over the previous one-year period.

The research shows that a network of satellites could one day form the infrastructure of a quantum internet.

"Through decades of efforts, the achievements obtained in our team have shown to people that quantum information science is not only of great scientific significance, but also of great practical value," said Pan, vice-president of the University of Science and Technology of China (USTC), in a note to China Daily. "I think that's why this time the Cleveland Award was awarded to us. It is a great inspiration to our team and the whole community of quantum information."

"Professor Pan and his team extended this limitation to many hundreds of kilometers using through-space communication to and from a satellite. This achievement required both conceptual skill in imagining the project and great technological skills across a range of disciplines to turn this idea into a reality," said Jeremy M. Berg, editor-in-chief of the *Science* family of journals.

"Professor Pan and his team are being recognized for taking a key tool for quantum communication to the next level and for communicating this excellent result clearly to the scientific community and to the public," said Berg.

Pan could not attend the award ceremony, as the US embassy in China didn't grant him a visa in time.

Juan Yin (center), professor at University of Science and Technology of China, receives the award of the Newcomb Cleveland Prize on behalf of the research team in Washington on Feb 14, 2019. (IMAGE FROM DONG LESHUO)

Juan Yin, professor at USTC, is the first author and chief designer of the payload on the quantum satellite. Yin accepted the award on behalf of the team.

"One hundred years ago, when Einstein came to China, he saw a weak and divided country, struggling to survive in the war. As China grows, we are happy to have the opportunity to contribute to the advancement of science with people all over the world," Yin said.

"This paper describes an exciting advance that has tremendous potential for application based on deep fundamental principles from physics," said Berg.

"In the future, we aim to have a global scale quantum network, which can provide fast secure communication services," said Pan.

"There are many techniques have to be broken through… lower weight, lower cost satellite can be launched soon," said Yin.

The American Association for the Advancement of Science is an American international nonprofit organization with the stated goals of promoting cooperation among scientists, defending scientific freedom, encouraging scientific responsibility and supporting scientific education and science outreach for the betterment of humanity.

For the first time in its 96-year history, the Newcomb Cleveland Prize, the oldest award of the American Association for the Advancement of Science, was awarded for research done by scientists in China.

Source: China Daily

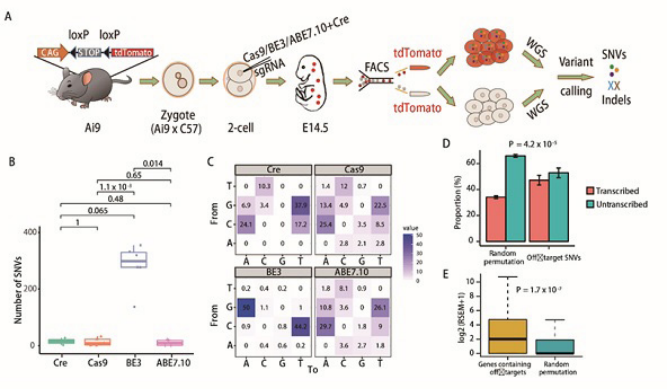
GOTI gives off-targets nowhere to hide

On March 1, a paper entitled "Cytosine base editor generates substantial off-target single nucleotide variants in mouse embryos" was published in *Science*. It described a breakthrough technique accomplished by the Institute of Neuroscience of the Chinese Academy of Sciences (CAS), the CAS-MPG Partner Institute for Computational Biology of the Department of Genetics of Stanford University and the Agricultural Genome Institute in Shenzhen. The researchers developed a method named "GOTI" (Genome-wide Off-target analysis by Two-cell embryo Injection) and applied it to evaluate the genome-wide off-target effects induced by genome editing tools including CRISPR/Cas9 and base editors and found that the cytosine base editor induced substantial off-target single nucleotide variants (SNVs). GOTI significantly improved the sensitivity of off-target detection in the absence of prediction in advance and could also detect randomly generated off-target variants. Therefore, GOTI provides a breathtaking new method for evaluation of the safety of genome editing tools that could be taken as an industry standard.

CRISPR/Cas9 is a new generation of gene editing tool that is now widely used. Since the appearance in 2012, it has aroused great attention for its efficiency and specificity. Scientists widely believe that clinical application of CRISPR/Cas9 and its derivatives will make great contributions to human health. However, the risk of off-targets has been a serious concern since the advent of CRISPR/Cas9. Off-target effects may potentially cause many side effects including cancer if CRISPR/Cas9 and its derivatives are used for clinical application. Thus, a robust off-target detection method will be the key to the clinical application of CRISPR/Cas9 and its derivatives.

A variety of off-target detection schemes had already been developed. However, most of them relied on the prediction of off-target sites based on sequence similarity, or in vitro amplification which may introduce large amounts of noise, making it difficult to separate off-target signals from background noise, especially single nucleotide variations. So, whether CRISPR/Cas9 would induce off-target effects has been controversial. Therefore, a precise off-target detection method independent of computational prediction and with high signal-to-noise ratio is needed.

In order to achieve this goal, Yang Hui's research team and collaborators established an off-target detection method named GOTI. When the mouse embryo develops into the two-cell stage, a blastomere is edited and labeled with a red fluorescent protein (tdTomato) and the other kept unedited. The progeny cells of the edited and non-edited blastomeres are then sorted by FACS based on tdTomato expression in gene-edited cells at embryonic day14.5 (E14.5). Whole genome sequencing (WGS) is then performed on the tdTomato+ and tdTomato- cells respectively. SNVs and indels are called by three algorithms in the tdTomato+ sample, with the tdTomato- sample from the same embryo as the reference. This method avoids the noise problem caused by in vitro amplification. Moreover, since the experimental group and the control group are from the same embryo, the genetic background is completely identical, so the difference between the two cell populations can be considered to be caused by genome editing tools.



Schematic diagram of the "GOTI" technique and experimental results. (A) Experimental design (B) Comparison of the total number of detected off-target SNVs. The number of SNVs for Cre-, Cas9-, BE3- and ABE7.10-treatedembryoswere14+/-12(SEM,n=2),12+/-4(SEM,n=11),283+/-32(SEM,n=6)and10 +/- 5 SNVs (SEM, n = 4), respectively (C) Distribution of mutation types. The number in each cell indicates the proportion of a certain type of mutation among all mutations (D) Off-target SNVs are enriched in the transcribed regions of the genome compared to random permutation. (E) Genes containing off-target SNVs were significantly higher expressed than random simulated genes in 4-cell embryos.

With the joint efforts of all members in Yang Hui's Lab and the cooperators, the GOTI system was successfully established. By application of this system, the team members first tested the CRISPR/Cas9 system and found that the well-designed CRISPR/Cas9 did not have obvious off-target effects. This result ended the long-existing controversy about CRISPR/Cas9 off-target effects. The team also tested another CRISPR/Cas9-derived technology, BE3, which was reported to introduce point mutations, and no significant off-target problems have been found in previous studies. However, under the detection of GOTI, BE3 was found to generate substantial off-target SNVs, which were not predicted by traditional off-target prediction methods. They also found that some of the off-target sites appear on the oncogene and tumor suppressor genes, so the classic version of BE3 is of great concern for clinical application at present.

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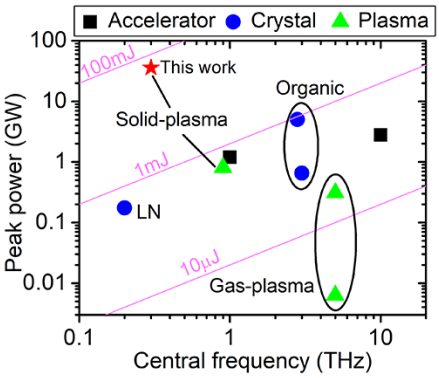
New record of Terahertz pulse energy driven by high-power lasers

Electromagnetic waves between infrared and microwaves are called as Terahertz (THz) radiation. It is a big challenge to generate intense THz radiation, which is significantly important for THz sciences and applications in many interdisciplinary fields. Although THz sources have been generated with electronic and optical techniques in recent decades, the THz pulse energy reported is lower than a millijoule. Results recently published in *PNAS* show that strong terahertz bursts with tens millijoules of energy, a world record for laboratory sources, can be obtained using high-power lasers.

Prof. Li Yutong's groups from the Institute of Physics of the Chinese Academy of Sciences, Prof. Zhang Jie's group from Shanghai Jiaotong University, in collaboration with Prof. David Neely from the Central Laser Facility of STFC Rutherford Appleton Laboratory, Prof. Paul McKenna from the University of Strathclyde, and UK scientists from the University of York have studied THz radiation from intense laser-metal foil interactions. The



Comparison of currently available high-peak-power THz sources. The data are referenced from previously reported typical results of THz sources based on conventional accelerators (black squares), optical rectification from crystals (blue circles) like lithium niobate (LN) and organic crystals, and gas/solid-density plasmas (green triangles). The red star represents the data presented in this paper. Magenta curves represent different energy ranges for half-cycle THz pulses.
[IMAGE FROM INSTITUTE OF PHYSICS]

Vulcan laser at the Central Laser Facility has achieved the record for the highest energy in a single pulse of terahertz radiation achieved in a laboratory.

The generation of such a strong THz source is mainly due to coherent transition radiation when an energetic electron bunch crosses the rear surface of the thin foil. The high-charge electron bunch is accelerated by the high intensity laser pulses in the mm-sized solid metal foil.

Terahertz are already used in tech in many fields. For example, the full body scanners for airport security checks. The powerful THz source driven by high power lasers provides opportunities to look at nonlinear dynamics in matter.

This study, entitled "Multi-millijoule coherent terahertz bursts from picosecond laser-irradiated metal foils" , was published in *PNAS*.

The study was supported by the National Science Foundation, the Ministry of Science and Technology of China, the Chinese Academy of Sciences, the National Postdoctoral Program for Innovative Talents, and the Newton and Engineering and Physical Sciences Research Council of the UK.

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Source: Institute of Physics

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Based on the off-target detection by GOTI, the team found that some of the gene editing tools represented by BE3 have unpredictable off-target risks, allowing the world to re-examine the risks of these emerging technologies. More importantly, this work has established a genetic editing off-target detection method with higher precision, breadth and accuracy than before. GOTI can be applied to develop a new generation of genome editing tools with higher accuracy and safety and thus establish the new Industry Standard.

This work was accomplished by Zuo Erwei from the Institute of Neuroscience, CAS, Sun Yidi and Wei Wu from CAS-MPG Partner Institute for Computational Biology, and Tang Yuanlong from the Agricultural Genome Institute at Shenzhen, under the direction of Yang Hui from the Institute of Neuroscience, Li Yixue from the CAS-MPG Partner Institute for Computational Biology and Lars M. Steinmetz from the Department of Genetics of Stanford University and the European Molecular Biology Laboratory (EMBL). It was also accompanied by other group members in the lab and the FACS animal care, gene editing facility. The study was sponsored by the R&D Program of China (2018YFC2000100 and 2017YFC1001302 to HY, 2017YFC0908405 to WW), the CAS Strategic Priority Research Program (XDB32060000), the National Natural Science Foundation of China (31871502, 31522037), the Shanghai Municipal Science and Technology Major Project (2018SHZDZX05), the Shanghai City Committee of science and technology project (18411953700, 18JC1410100) and an NIH P01 Center grant (P01HG00020527 to L.M.S.).

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Source: Shanghai Institute of Neuroscience

ESA gives go-ahead for SMILE mission with China

The Solar wind Magnetosphere Ionosphere Link Explorer, SMILE, has been given the green light for implementation by the European Space Agency's Science Programme Committee. The announcement clears the way for full development of this new mission to explore the sun-Earth connection, which will be conducted in collaboration with China.

SMILE is expected to revolutionize scientists' understanding of the physical processes taking place during the continuous interaction between particles in the solar wind and the magnetosphere, Earth's magnetic shield.

The mission will be a major scientific endeavor in collaboration between the ESA and China, following the success of the Double Star / Tan Ce mission which flew between 2003 and 2008. Unlike Double Star, which started out as a China-only project, SMILE was envisaged from the start as a joint ESA-China mission.

The scientific collaboration began with two workshops, one held in China and the other in Europe that facilitated collaboration between Chinese and European-based researchers. This was followed by a joint call for proposals issued in January 2015 by ESA's Directorate of Science and Robotic Exploration and the Chinese Academy of Sciences (CAS).

Following selection in November 2015 as well as detailed studies by the ESA and CAS, three European industrial contractors and the Science Study Team finalized the mission's architecture, including the space and ground elements that are required to fulfill the science requirements.

Under current plans, the 2,200 kg spacecraft will be launched by a European Vega-C rocket or Ariane 6-2 in 2023, and subsequently be placed in a highly inclined elliptical orbit around Earth. Every 51 hours, SMILE will fly out to 121,000 km – almost one third of the distance to the moon – giving it a prolonged view of Earth's northern polar regions. It will then return to within 5,000 km of the planet in order to download its treasure trove of stored data to an ESA ground station in Antarctica and the CAS ground station in Sanya, China.

From this unusually elongated orbit, the satellite will be able to make continual observations of key regions in near-Earth space over a period of more than 40 hours. These will include simultaneous images and movies of the magnetopause – the boundary where Earth's magnetosphere meets the solar wind – as well as the polar cusps, and the region illuminated by the Northern Lights, or aurora borealis.

SMILE will offer scientists the chance to observe these key regions of sun-Earth interaction for such long periods of time for the first time. The mission will last three years.

SMILE – the Solar wind Magnetosphere Ionosphere Link Explorer – aims to form an accurate picture of solar-terrestrial magnetospheric physics. [IMAGE CREDIT: ESA/ATG MEDIALAB]

The science payload consists of four instruments: two from Europe and Canada, and two from China.

The innovative wide-field Soft X-ray Imager (SXI), provided by the United Kingdom Space Agency and other European institutions, will obtain unique measurements of the regions where the solar wind impacts the magnetosphere. The Canada-led Ultra-Violet Imager (UVI) will study global distribution of the auroras.

The two Chinese instruments, the Light Ion Analyser (LIA) and Magnetometer (MAG), will measure the energetic particles in the solar wind and changes in the local magnetic field.

The ESA is also responsible for the payload module, spacecraft test facilities, the launcher and launch campaign, and the primary ground station, and will share science operations with CAS. A contract for industry to build the payload module will be announced in due course, and all spacecraft assembly and test activities will take place in Europe.

The National Space Science Center (NSSC/CAS) in China is responsible for the spacecraft platform and testing, and mission and science operations. The platform will be built in Shanghai by the Innovation Academy for Microsatellites.

According to ESA's SMILE study scientist, Philippe Escoubet, the mission will enable important breakthroughs in studies of the ever-changing interaction between Earth's magnetic field and the solar wind.

Source: European Space Agency

An applied mathematician's life in China

By CLAUDE-MICHEL BRAUNER
University of Bordeaux, France

The first time I visited China was in June, 1988, when I was invited to be a keynote speaker at a conference in Shanghai organized by the late Professor Guo Benyu and Academician Shi Zhongci. Recently, I read the tragic novel by Wang Anyi, "The Song of Everlasting Sorrow," which follows a beauty queen from 1945 to her murder in 1986. My memories of Shanghai in 1988 are a reflection of Wang's description of Shanghai in the 80s. On my way to Shanghai, I visited Peking University and Xi'an Jiaotong University.

Interestingly, Shi Zhongci was a professor at the Department of Mathematics of the University of Science and Technology of China (USTC) from 1965 to 1986. In 1993, Professor Shi became the first director of the State Key Laboratory of Scientific and Engineering Computing (LSEC), located in the Institute of Computational Mathematics and Scientific/Engineering Computing of CAS. The current director is Professor Zhang Linbo (my academic brother). I have had the great pleasure to meet Academician Shi Zhongci and his wife again several times.

After my visit in June, 1988, I waited several years to return to China. In 2009, Professor Shen Jie (also one of my academic brothers) invited me to join his newly-established laboratory in the School of Mathematical Sciences of Xiamen University (XMU). The campus of XMU, located adjacent to the Nanputuo Temple, is famous for its beautiful scenery and park-like environment.

My initial contract was for only three years. However, I eventually spent eight academic years as a member of the faculty of the School. For three of those years, I served as a High-end Foreign Expert within the Thousand Talents Program. My role had several components: teaching at the graduate and undergraduate level, advising PhD students, publishing papers, and assisting and promoting

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international relationships for the School, and with France in particular. I developed research programs in two main directions: first, mathematical models in biology with particular attention to HIV propagation; and second, mathematical models in combustion, including instability of flames. The latter direction is related to stability issues in Free Boundary Problems, where a flame is viewed as a free interface. As is well known, interface phenomena are commonplace in physics, chemistry, biology, and the various disciplines that bridge these fields. In Xiamen, I advised three PhD students who, after a stay in France or the United States, are currently assistant or associate professors at Chinese universities. They have become three of my sixty-nine scientific descendants.

As the representative of the French Society for Industrial and Applied Mathematics in China, I was involved in the development of Sino-French relations in applied mathematics during the ICIAM 2015 Congress in Beijing, and also within the framework of the Sino-French Associated International Laboratory (LIASFMA), co-chaired by Professors Li Tatsien (Fudan University) and Jean-Michel Coron (Sorbonne University). In June 2014, LIASFMA was established at Xiamen University on the occasion of the first Sino-French Conference on Computational and Applied Mathematics as part of the celebration to mark the 50th anniversary of diplomatic relations between France and China. The Office for Science and Technology of the French Embassy in Beijing and the CNRS China Office have always granted me their full support.

In September, 2017, I departed Xiamen University as I had received an invitation from Professor Liang Xing to join the School of Mathematical Sciences of the University of Science and Technology of China (USTC) as a long-term visiting professor. It was sad for me to leave what had been my professional environment for so long and the city of Xiamen, which in 2016 conferred upon me the Egret Friendship Award. However, the time had come for me to face a new challenge in one of the top universities in China and Asia. At USTC I have been given an exceptionally warm welcome and have already taught a high level course. Simultaneously I initiated a new research program about Hopf bifurcation in premixed flames. Incidentally I had an interesting contact at the State Key Laboratory of Fire Science (SKLFS). As shown above, mathematical modeling of combustion and flame is one my favorite topics, because flame is an intricate physical system involving fluid dynamics, multistep chemical kinetics, and molecular and radiative heat transfer.

During my years in China, I have gained a lot, from many aspects: scientific, cultural, and human. I have visited several places in Chinese mainland, as well as Hong Kong. I have come to love China and its culture. I have formed many everlasting Chinese friendships, both here in China and also in France. Although, by now, China has become my second country, I sometimes feel totally lost. For instance, when I go down a stairway, I wonder what awaits me; will I arrive in Paris (where my family lives) or in Hefei? In conclusion, I would like to quote the following words of Kongfuzi: *Choose a job you love and you will never have to work a day in your life.* That describes perfectly a mathematician's life!

Source: USTC

BeiDou achieves real-time transmission of deep-sea data

China has achieved real-time transmission of deep-sea data at 6,000-meter depth through its self-developed BeiDou satellites for the first time, a move essential to more secure, independent and reliable deep-sea data transmission.

China's most sophisticated research vessel Kexue (Science) returned to the eastern port city of Qingdao on Jan 31, 2019 after wrapping up a 74-day, 12,000-nautical mile expedition. During the trip, Chinese scientists maintained and upgraded the country's scientific observation network in the West Pacific, according to the Institute of Oceanology under the Chinese Academy of Sciences (CAS).

Researchers replaced batteries on 20 sets of submersible buoys on the network, optimized their positions and installed BeiDou satellite communication modules in them.

As the low-volume submersible buoys powered by batteries can only be retrieved once a year, the communication modules were designed to be tiny, power saving and run steadily.

"The data collected by the submersible buoys, including the temperature, salinity, flowing speed and direction of seawater, should be transmitted back to the ground lab by satellites. The amount of data was huge," said Wang Jianing, a researcher at the institute. So they developed multi-module communication and transmission technology, greatly lifting transmission efficiency.

The breakthrough research vessel Kexue made changed the situation. Before, real-time observation of marine data had relied on foreign remote sensing satellites. Now there was improved data transmission security and reliability, according to Wang Fan, director of the Institute.

China began to establish the real-time scientific observation network in the West Pacific in 2014, and realized real-time transmission of deep-sea data in 6,000-meter depth in this expedition, with the depth range extending from 1,000 meters in 2016 to 3,000 meters in 2017.

Chinese research vessel Kexue, returns to Qingdao on Jan 31, 2019 from a scientific expedition to the West Pacific. [IMAGE FROM IOCAS]

Researchers also carried out successful experiments on real-time transmission of deep-sea data of 10,000-meter depth in the Pacific Ocean's Mariana Trench, laying the technical foundation for achieving further depth.

There are 20 sets of submersible buoys, four sets of large floating buoys and some pieces of on-board mobile observation equipment in China's observation network for scientific research over the tropical West Pacific, which has acquired deep-sea data for five consecutive years. Wang said the data could enhance the precision in ocean climate and environment forecasts.

The tropical West Pacific is home to the world's most sophisticated waters, with the strongest interchange of energy and materials between earth and the ocean.

It has a close connection with the occurrence of El Nino and its duration, which has a significant influence on floods and droughts in China. And the El Nino weather phenomenon, characterized by a warming in the Pacific Ocean, has a profound impact on extreme weather conditions, according to the institute.

With a tonnage of 4,711 tonnes, Kexue is 99.8 meters long and 17.8 meters wide, with a cruising capacity of 15,000 nautical miles.

Kexue started its first expedition in April 2014 and has fulfilled several missions in the West Pacific Ocean and the South China Sea, with a more than 250-day voyage every year.

China's BeiDou navigation system started to provide global services in December 2018.

Source: Xinhua