中國科學院
CHINESE ACADEMY OF SCIENCES

CASNewsletter

NO. 176 • June 2021

Fun Science for Young Minds

Executive Editor:
Zhang Qingquan
Designer: Tian Chi

Learn more

Edited by Bureau of International Co-operation, Chinese Academy of Sciences

CAS Newsletter – Monthly – Editorial Board: 52, Sanlihe Road, Beijing, 100864, China



China's science academy holds Public Science Day


The Chinese Academy of Sciences has treated science lovers across the country to a two-day display of advanced experiments and open research facilities at its 17th Public Science Day.

Starting on May 22, more than 100 research institutions under the academy nationwide opened their key laboratories, botanical gardens, observatories and field stations to the public.

Equipment for public view included unmanned vehicles, medical robots and quantum computer models. Some institutions conducted online and offline science popularization activities, including science-themed musical dramas, magic shows and lectures for young visitors.

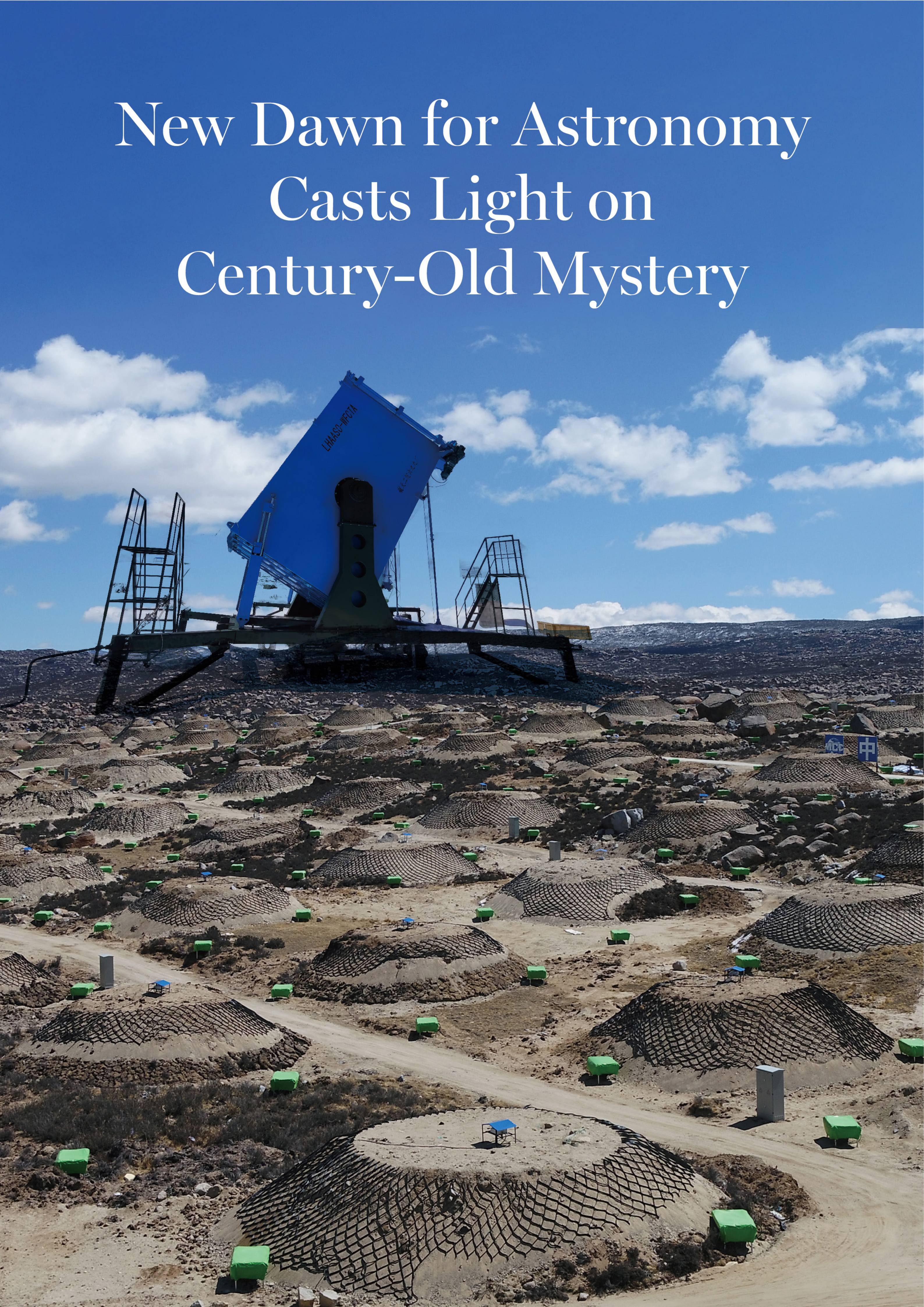
Renowned scientists, science fiction writers and aerospace experts also came together to celebrate the event, which ended on May 23.

China's highest academic institution in the natural sciences, the academy has organized a Public Science Day since 2004.

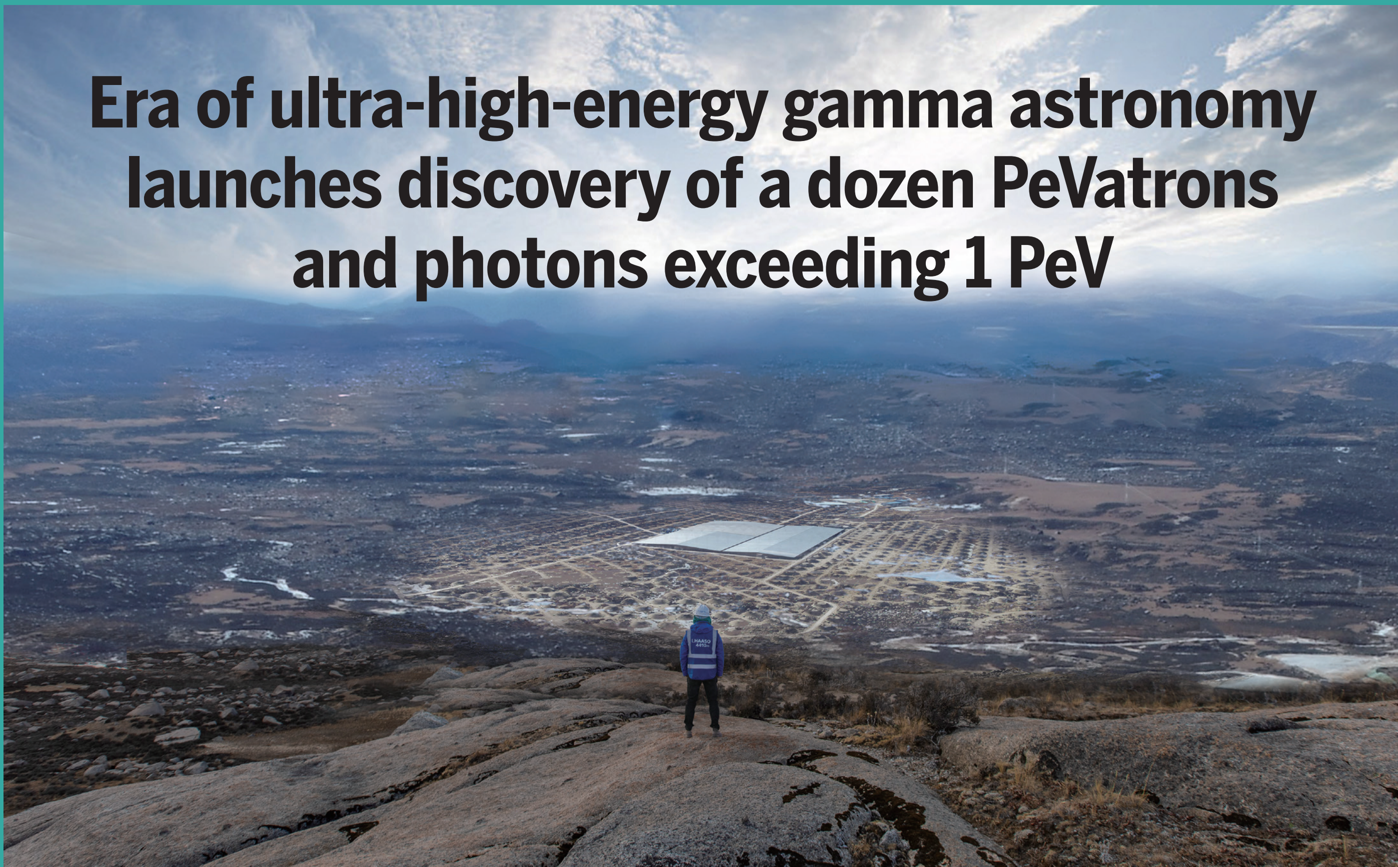
Source: Xinhua


A NEW ERA
for
ASTRONOMY

New Dawn for Astronomy Casts Light on Century-Old Mystery



Era of ultra-high-energy gamma astronomy launches discovery of a dozen PeVatrons and photons exceeding 1 PeV



China's Large High Altitude Air Shower Observatory (LHAASO)—one of the country's key national science and technology infrastructure facilities—has found a dozen ultra-high-energy (UHE) cosmic accelerators within the Milky Way. It has also detected photons with energies exceeding 1 peta-electron-volt (quadrillion electron-volts or PeV), including one at 1.4 PeV, which is the highest energy photon ever observed. These findings overturn our traditional understanding of the Milky Way and open up an era of UHE gamma astronomy. They prompt us to rethink the mechanism by which high-energy particles are generated and propagated in the Milky Way. In addition, they encourage us to explore more deeply violent celestial phenomena and their physical processes and to test basic physical laws under extreme conditions. These discoveries were published in the journal *Nature* on May 17 and were completed by the LHAASO International Collaboration, which is led by the Institute of High Energy Physics (IHEP) of the Chinese Academy of Sciences (CAS).

The LHAASO Observatory is still under construction. The cosmic accelerators—known as PeVatrons since they accelerate particles to the PeV range—and PeV photons were discovered using the first half of the detector array, which was finished at the end of 2019 and operated for 11 months in 2020.

Photons with energies exceeding 1 PeV were detected in a very active star-forming region in the constellation Cygnus. LHAASO also detected 12 stable gamma ray sources with energies up to about 1 PeV and the photon signals seven standard deviations greater than the surrounding background. These sources are located at positions in our galaxy that can be measured with an accuracy better than 0.3°. They are the brightest Milky Way gamma ray sources in LHAASO's field of view.

Although the accumulated data from the first 11 months of operation only allowed us to observe those sources, all of them emit so-called UHE photons, i.e., gamma rays above 0.1 PeV. The results show that the Milky Way is full of PeVatrons, while the largest accelerator on Earth (LHC at CERN) can only accelerate particles to 0.01 PeV. Scientists have already determined that cosmic ray accelerators in the Milky Way have an energy limit. Until now, the predicted limit was around 0.1 PeV, with no higher gamma-ray spectrum anticipated.

>> **PAGE 6**

>> PAGE 5

But LHAASO's discovery has increased this "limit," since the spectra of most sources are not truncated. These findings launch a new era for UHE gamma astronomic observations. They show that non-thermal radiation celestials, such as young massive star clusters, supernova remnants, pulsar wind nebulas and so on—represented by Cygnus star-forming regions and the Crab nebula—are the best candidates for finding UHE cosmic rays in the Milky Way.

Through UHE gamma astronomy, the century-old mystery of the origin of cosmic rays may soon be solved. LHAASO will prompt scientists to rethink the mechanisms of high energy cosmic ray acceleration and propagation in the Milky Way. It will also allow researchers to explore extreme astrophysical phenomena and their corresponding processes, enabling the examination of the basic laws of physics under extreme conditions.

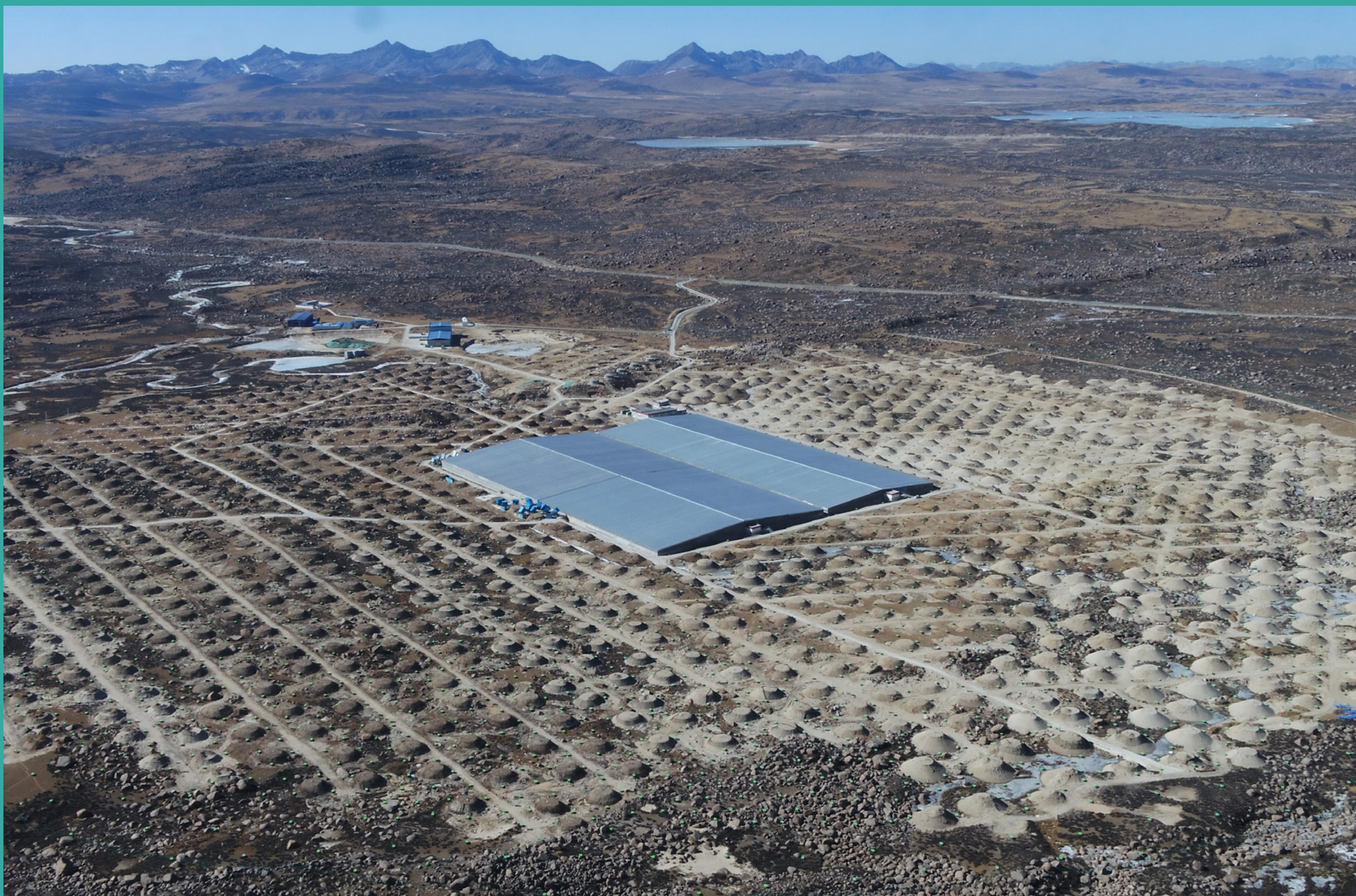
Extended Materials:

LHAASO and Its Core Scientific Goals

LHAASO is a major national scientific and technological infrastructure facility focusing on cosmic ray observation and research. It is located 4,410 meters above sea level on Haizi Mountain in Daocheng County, Sichuan Province. When construction is completed in 2021, LHAASO's particle detector arrays will comprise 5,195 electromagnetic particle detectors and 1,188 muon detectors located in the square-kilometer complex array (KM2A), a 78,000 m^2 water Cherenkov detector array (WCDA), and 18 wide-field-of-view Cherenkov telescopes (WFCTA). Using these four detection techniques, LHAASO will be able to measure cosmic rays omnidirectionally with multiple variables simultaneously. The arrays will cover an area of about 1.36 km^2.

LHAASO's core scientific goal is to explore the origin of high-energy cosmic rays and study the evolution of the universe, the motion and interaction of high-energy astronomical celestials, and the nature of dark matter. LHAASO will extensively survey the universe (especially the Milky Way) for gamma ray sources. It will precisely measure their energy spectra over a broad range—from less than 1 TeV (trillion electron-volts or tera-electron-volts) to more than 1 PeV. It will also measure the components of diffused cosmic rays and their spectra at even higher energies, thus revealing the laws of the generation, acceleration and propagation of cosmic rays, as part of the exploration of new physics frontiers.

>> PAGE 7



Aerial photograph of LHAASO [IMAGE: IHEP]

>> **PAGE 6**

PeVatrons and PeV Photons

The signal of UHE photons around PeVatrons is so weak that just one or two photons at PeV energy can be detected using 1 km^2 of detectors per year even when focusing on the Crab Nebula, known as the "standard candle for gamma astronomy." What's worse, those one or two photons are submerged in tens of thousands of ordinary cosmic rays. The 1,188 muon detectors in LHAASO's KM2A are designed to select photon-like signals, making LHAASO the most sensitive UHE gamma ray detector in the world. With its unprecedented sensitivity, in just 11 months the half-sized KM2A detected one photon around 1 PeV from the Crab Nebula. In addition, KM2A found 12 similar sources in the Milky Way, all of which emit UHE photons and extend their spectra continuously into the vicinity of 1 PeV. Even more importantly, KM2A has detected a photon with energy of 1.4 PeV—the highest ever recorded. It is clear that LHAASO's scientific discoveries represent a milestone in identifying the origin of cosmic rays. To be specific, LHAASO's scientific breakthroughs fall into the following three areas:

1) Revealing the ubiquity of cosmic accelerators capable of accelerating particles to energies exceeding 1 PeV in the Milky Way. All the gamma ray sources that LHAASO has effectively observed radiate photons in a UHE range above 0.1 PeV, indicating that the energy of the parent particles radiating the gamma rays must exceed 1 PeV. As a matter of convention, these sources must have significances of photon signals five standard deviations greater than the surrounding background. The observed energy spectrum of these gamma rays has not truncated above 0.1 PeV, demonstrating that there is no acceleration limit below PeV in the galactic accelerators.

This observation violates the prevailing theoretical model. According to current theory, cosmic rays with energies in the PeV range can produce gamma rays of 0.1 PeV by interacting with surrounding gases in the accelerating region. Detecting gamma rays with energies greater than 0.1 PeV is an important way to find and verify

>> **PAGE 9**

HISTORY OF COSMIC RAY RESEARCH IN CHINA

Cosmic ray research in China has experienced three stages. LHAASO represents the third generation of high-altitude cosmic ray observatories. High-altitude experiments are a means of making full use of the atmosphere as a detector medium. In this way, scientists can observe cosmic rays on the ground, where the size of the detector can be much larger than in a space-borne detector outside the atmosphere. This is the only way to observe cosmic rays at very high energy.

In 1954, China's first cosmic ray laboratory was built on Luoxue Mountain in Dongchuan, Yunnan Province, at 3,180 meters above sea level.

In 1989, the Sino-Japanese cosmic ray experiment ASγ was built at an altitude of 4,300 meters above sea level at Yangbajing, Tibet Autonomous Region.

In 2006, the joint Sino-Italian ARGO-YBJ experiment was built at the same site.

In 2009, at the Xiangshan Science Forum in Beijing, Professor Cao Zhen proposed to build a large-scale composite detection array (i.e. LHAASO) in a high-altitude area.

The LHAASO project was approved in 2015 and construction began in 2017.

By April 2019, construction was 25 percent complete and scientific operation had begun.

By January 2020, an additional 25 percent had been completed and put into operation. In December of the same year, 75 percent of the facility had been completed.

The entire facility will be completed in 2021.

LHAASO has already become one of the world's leading UHE gamma detection facilities, and will operate for a long time. With it, scientists will be able to extensively study the origin of cosmic rays.

>> **PAGE 7**

PeV cosmic ray sources. Since previous international mainstream detectors work below this energy level, the existence of PeV cosmic ray accelerators had not been solidly confirmed before. But now LHAASO has revealed a large number of PeV cosmic acceleration sources in the Milky Way, all of which are candidates for being UHE cosmic ray generators. This is a crucial step toward determining the origin of cosmic rays.

2) Beginning an era of "UHE gamma astronomy." In 1989, an experimental group at the Whipple Observatory in Arizona successfully discovered the first object emitting gamma radiation above 0.1 TeV, marking the onset of the era of "very-high-energy" gamma astronomy. Over the next 30 years, more than 200 "very-high-energy" gamma ray sources were discovered. However, the first object emitting UHE gamma radiation was not detected until 2019. Surprisingly, by using a partly completed array for less than a year, LHAASO has already boosted the number of UHE gamma ray sources to 12.

With the completion of LHAASO and the continuous accumulation of data, we can anticipate finding an unexplored "UHE universe" full of surprising phenomena. It is well known that background radiation from the Big Bang is so pervasive it can absorb gamma rays with energies greater than 1 PeV. Even if gamma rays were produced beyond the Milky Way, we wouldn't be able to detect them. This makes LHAASO's observational window so special.

3) Photons with energies greater than 1 PeV were first detected from the Cygnus region and the Crab Nebula. The detection of PeV photons was a milestone in gamma astronomy. It fulfilled the dream of the gamma astronomy community and has long been a strong driving force in the development of research instruments in the field. In fact, one of the main reasons for the explosion of gamma astronomy in the 1980s was the challenge of the PeV photon limit. The star-forming region in the direction of Cygnus is the brightest area in the northern territory of the Milky Way, with a large number of massive star clusters. Massive stars live only on the order of one million years, so the clusters contain enormous stars in the process of birth and death, with a complex strong shock environment. They are ideal "particle astrophysics laboratories," i.e., places for accelerating cosmic rays.

The first PeV photons found by LHAASO were from the star-forming region of the constellation Cygnus, making this area the best candidate for exploring the origin of UHE cosmic rays. Therefore, much attention has turned to LHAASO and multi-wavelength observation of this region, which could offer a potential breakthrough in solving the "mystery of the century."

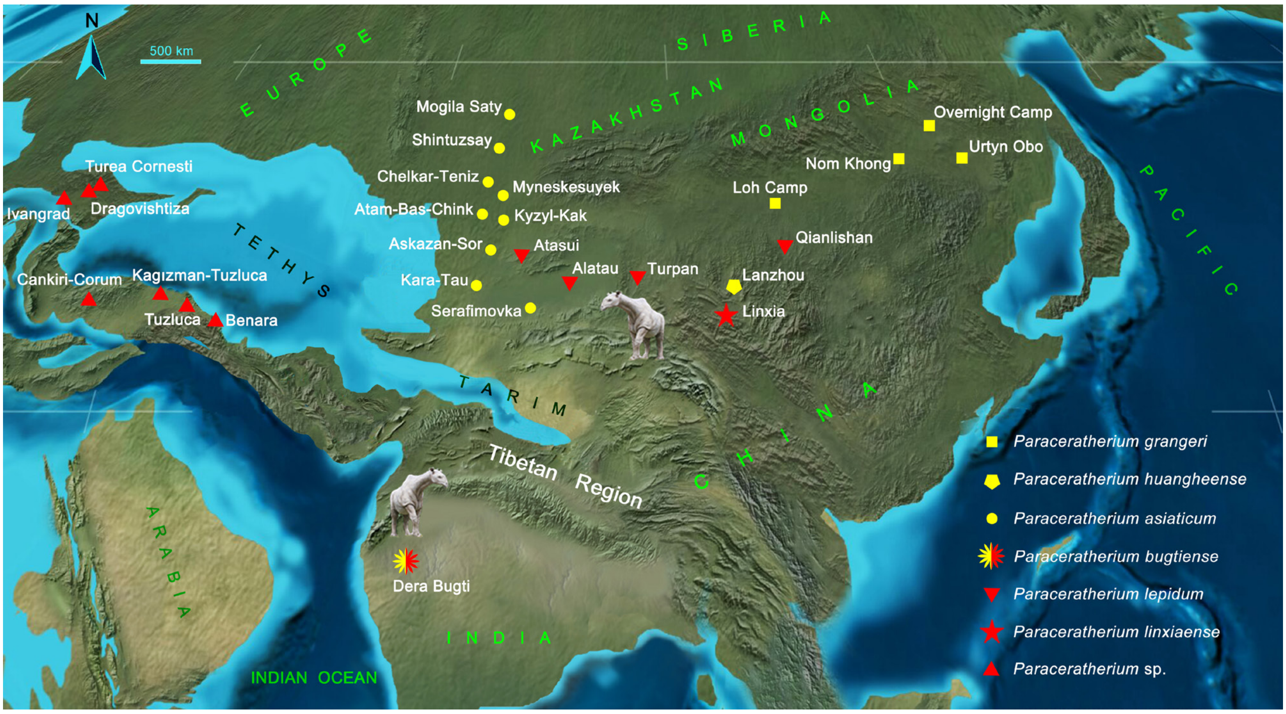
Extensive observational studies of the Crab Nebula over the years have made the celestial body almost the only standard gamma ray source with a clear emission mechanism. Indeed, precise spectrum measurements across 22 orders of magnitude clearly reveal the signature of an electron accelerator. However, the UHE spectra measured by LHAASO, especially photons at PeV energy, seriously challenge this "standard model" of high-energy astrophysics and even the more fundamental theory of electron acceleration.

Technology Innovations

LHAASO has developed and/or improved: 1) clock synchronization technology over long distances that ensures timing synchronization accuracy to the sub-nanosecond level for each detector in the array; 2) multiple parallel event trigger algorithms and their realization, with the help of high-speed front-end signal digitization, high-speed data transmission and large on-site computing clusters; and advanced detection technologies include 3) silicon photo multipliers (SiPM) and 4) ultra-large photocathode micro-channel plate photomultiplier tubes (MCP-PMT). They are being employed at LHAASO on a large scale for the first time. They have greatly improved the spatial resolution of photon measurements and lowered the detection energy threshold. These innovations allow detectors to achieve unprecedented sensitivity in exploring the deep universe at a wide energy range. LHAASO provides an attractive experimental platform for conducting interdisciplinary research in frontier sciences such as atmosphere, high-altitude environment and space weather. It is also a base for international cooperation on high-level scientific research projects.

For more information, please contact:
Professor Cao Zhen
E-mail: caozh@ihep.ac.cn
Mr. Bai Yunxiang
E-mail: baiyx@ihep.ac.cn
Institute of High Energy Physics (IHEP), Chinese Academy of Sciences

Source: Institute of High Energy Physics (IHEP), Chinese Academy of Sciences



Distribution and migration of *Paraceratherium* in the Oligocene Eurasia. Localities of the early Oligocene species were marked by the yellow color, and the red indicates the late Oligocene species. [IMAGE: IVPP]

New discovery shows Tibet as crossroads for giant rhino dispersal

The giant rhino, *Paraceratherium*, is considered the largest land mammal that ever lived and was mainly found in Asia, especially China, Mongolia, Kazakhstan, and Pakistan. How this genus dispersed across Asia was long a mystery. But a new discovery has now shed light on this process.

Professor Deng Tao from the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) of the Chinese Academy of Sciences (CAS) and his collaborators from China and the United States recently reported a new species, *Paraceratherium linxiaense* sp. nov., which offers important clues to the dispersal of giant rhinos across Asia.

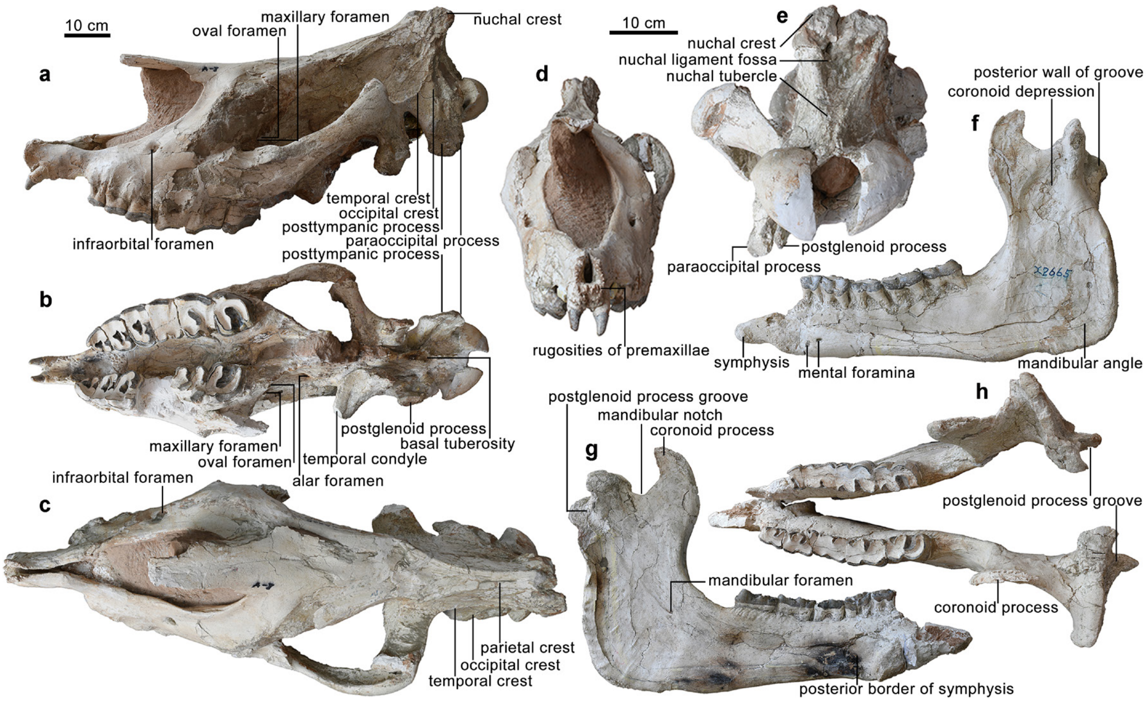
The study was published in *Communications Biology* on June 17.

Ecological reconstruction of giant rhinos and their accompanying fauna in the Linxia Basin during the Oligocene [IMAGE: CHEN YU]

The new species' fossils comprise a completely preserved skull and mandible with their associated atlas, as well as an axis and two thoracic vertebrae from another individual. The fossils were recovered from the Late Oligocene deposits of the Linxia Basin in Northwest China's Gansu Province, which is located on the northeastern border of the Tibetan Plateau.

Phylogenetic analysis yielded a highly parsimonious tree, which places *P. linxiaense* as a derived giant rhino, within the monophyletic clade of the Oligocene Asian *Paraceratherium*. Within the *Paraceratherium*

>> **PAGE 11**



Holotype of *Paraceratherium linxiaense* sp. nov. Skull and mandible share the scale bar, but both the anterior and nuchal views have an independent scale bar.
[IMAGE: IVPP]

>> **PAGE 10**

clade, the researchers' phylogenetic analysis produced a series of progressively more-derived species — from *P. grangeri*, through *P. huangheense, P. asiaticum,* and *P. bugtiense*, finally terminating in *P. lepidum* and *P. linxiaense. P. linxiaense* is at a high level of specialization, similar to *P. lepidum*, and both are derived from *P. bugtiense*.

Adaptation of the atlas and axis to the large body and long neck of the giant rhino already characterized *P. grangeri* and *P. bugtiense*, and was further developed in *P. linxiaense*, whose atlas is elongated, indicative of a long neck and higher axis with a nearly horizontal position for its posterior articular face. These features correlate with a more flexible neck.

The giant rhino of western Pakistan is from the Oligocene strata, representing a single species, *Paraceratherium bugtiense*. On the other hand, the rest of the genus *Paraceratherium*, which is distributed across the Mongolian Plateau, northwestern China, and the area north of the Tibetan Plateau to Kazakhstan, is highly diversified.

The researchers found that all six species of *Paraceratherium* are sisters to *Aralotherium* and form a monophyletic clade in which *P. grangeri* is the most primitive, succeeded by *P. huangheense* and *P. asiaticum*.

The researchers were thus able to determine that, in the Early Oligocene, *P. asiaticum* dispersed westward to Kazakhstan and its descendant lineage expanded to South Asia as *P. bugtiense*. In the Late Oligocene, *Paraceratherium* returned northward, crossing the Tibetan area to produce *P. lepidium* to the west in Kazakhstan and *P. linxiaense* to the east in the Linxia Basin.

The researchers noted the aridity of the Early Oligocene in Central Asia at a time when South Asia was relatively moist, with a mosaic of forested and open landscapes. "Late Oligocene tropical conditions allowed the giant rhino to return northward to Central Asia, implying that the Tibetan region was still not uplifted as a high-elevation plateau," said Professor Deng.

During the Oligocene, the giant rhino could obviously disperse freely from the Mongolian Plateau to South Asia along the eastern coast of the Tethys Ocean and perhaps through Tibet. The topographical possibility that the giant rhino crossed the Tibetan area to reach the Indian-Pakistani subcontinent in the Oligocene can also be supported by other evidence.

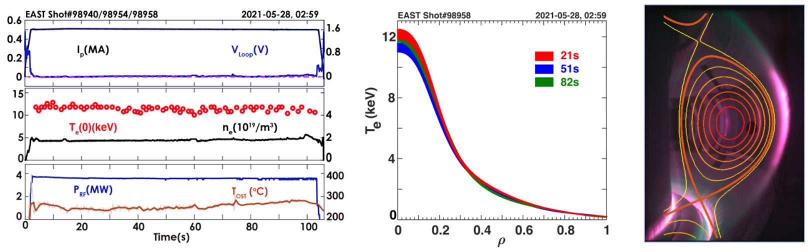
Up to the Late Oligocene, the evolution and migration from *P. bugtiense* to *P. linxiaense* and *P. lepidum* show that the Tibetan Plateau was not yet a barrier to the movement of the largest land mammal.

This research was supported by CAS, the National Natural Science Foundation of China, and the Second Comprehensive Scientific Expedition on the Tibetan Plateau.

Source: Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), Chinese Academy of Sciences

EAST achieves a plasma temperature of 120 million degrees centigrade for 101 seconds

On May 28, after almost 10 thousand experiments, EAST (Experimental Advanced Superconducting Tokamak) broke the world record with a plasma temperature of 120 million degrees centigrade for 101 seconds. In addition, EAST recorded a plasma temperature of 160 million degrees centigrade for 20 seconds.



EAST achieves a plasma temperature of 120 million degrees centigrade for 101 seconds.
[IMAGE: ASIPP]

It is of great significance to study the multi-scale interaction physics and electron heat transport under low collision rate and low momentum, and to find an effective heating path for fuel ions while maintaining self-sustaining combustion of plasma for magnetic confinement fusion. The 100-million-degree operation mode in EAST is an excellent platform for the study of multi-scale interaction physics and electron heat transport under low collision rate and low momentum.

In June 2020, EAST was comprehensively improved when its diverter upgrading was completed. A series of technical problems, such as steady-state high-power heating, completely non-inductive high-current drive, high-precision plasma real-time control, and interaction between high thermal load plasma and shield materials, were solved during the physical experiments. This world record—achieving a plasma temperature of 120 million degrees centigrade for 101 seconds, increased by five times the 100 million degrees 20 seconds achieved in EAST last year.

Nuclear fusion energy has the outstanding advantages of abundant resources, no carbon emission, cleanliness and safety, and will be one of the ideal clean energies for mankind in the future. It can make an important contribution to the realization of carbon neutrality. The two major difficulties in realizing nuclear fusion power generation are realizing multi-billion-degree ignition and stable long-term confinement control. It is particularly difficult to maintain plasma of hundreds of millions of degrees for long periods of time; this requires the interaction of a hundred-million-degree plasma with a superconducting magnet of minus 269 degrees, and a high thermal load plasma with the shield material, dynamic precision control and other extreme conditions highly integrated at the same time in an organic combination, which is very challenging.

Continuous steady-state operation under the condition of 100-million-degree high temperature plasma is a necessary condition for fusion power generation in the future. This world record is the verification of a series of key technologies that were first operated in EAST and must be adopted in future fusion reactors, such as an all-metal active water cooling first wall, a high-performance tungsten divertor, steady-state high-power wave heating and precision control of plasma configuration.

EAST is currently the world's only magnetic confinement fusion experimental device with a heating mode and partial filter structure similar to that of ITER (International Thermonuclear Experimental Reactor), and is the only experimental facility that can fully demonstrate and verify the future 400-second scientific research of ITER in the 100-second scale. The series of innovative research results and technological accumulation on EAST also provide a solid scientific and technological foundation for China's construction of a fusion engineering experimental reactor.

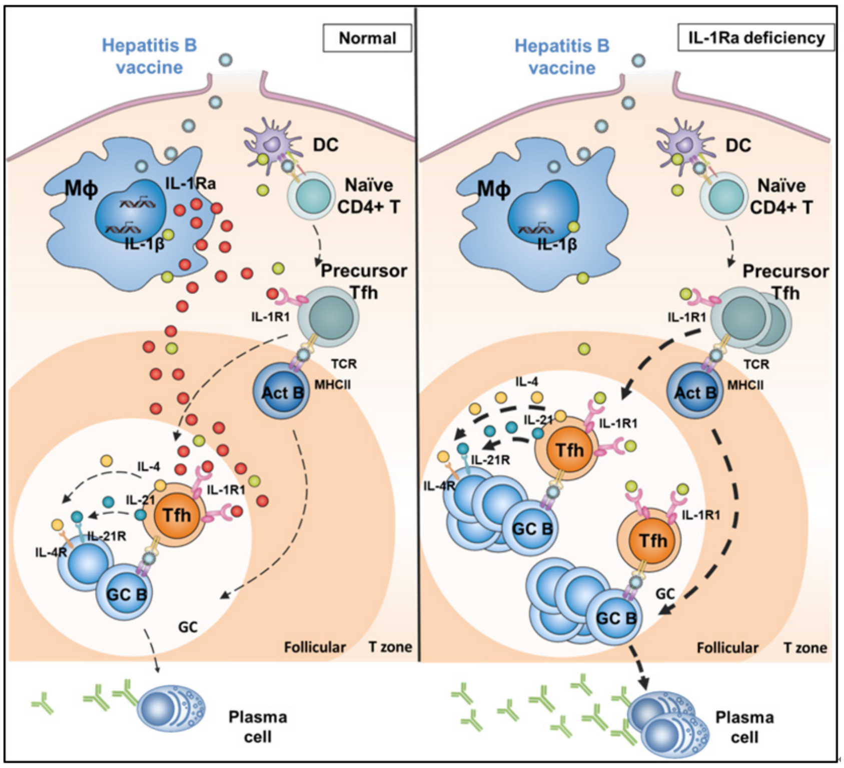
For more information, please contact:
Professor Gong Xianzu
E-mail: xz_gong@ipp.ac.cn
Institute of Plasma Physics (ASIPP), Chinese Academy of Sciences

Source: Institute of Plasma Physics (ASIPP), Chinese Academy of Sciences

A new mechanism to improve antibody response and vaccine protection

The COVID-19 pandemic has revealed the essential role of vaccines in preventing infection and controlling the spread of an infectious disease. However, the established methods for vaccine production cannot achieve a 100 percent protection effect after vaccination. In addition to ethnic and individual differences, the types of vaccine significantly contribute to vaccine efficacy. Since the 1980s, recombinant virus-like particle (VLPs) vaccines (such as the hepatitis B vaccine and the HPV vaccine) have become leaders in the field due to their superior safety, strong immunogenicity and excellent protection rate. However, the VLPs vaccines also have some defects; for example, the antibody level in 5-10 percent of hepatitis B vaccine recipients was unable to reach the immune protection titer (those recipients are collectively referred to as vaccine non-responders). They have a high prevalence of hepatitis B virus infection, which seriously impedes elimination of hepatitis B.

To overcome this obstacle and provide a key solution, PhD students Lin Xinwen and Li Shuran and postdoctoral fellow Trix Twelkmeyer, who are supervised by Professor Tang Hong at the Institut Pasteur of Shanghai (IPS) of the Chinese Academy of Sciences (CAS), published an online article entitled "Homeostatic regulation of T follicular helper and antibody response to particle antigens by IL-1Ra of medullary sinus macrophage origin" in *PNAS* on April 20, 2021.



Working model: HBV vaccine induces macrophages to produce high level of IL-1Ra in the draining lymph node, inhibiting Tfh cell activation and antibody production. [IMAGE: IPS]

The study reveals that hepatitis B vaccine and some other particle antigens specifically induce a kind of lymph node specific macrophage, and medullary sinus macrophages (MSM), to produce a cytokine called interleukin-1 receptor antagonist (IL-1Ra), which is the "culprit" inhibiting B cells to produce high-level antibodies. The characteristic of the virus-like particle vaccine is similar to that of the virus. It will enter the draining lymph nodes once inside the body, where it contacts the subcapsular lymph sinus macrophages (SCS) of the lymph nodes initially, and then spreads to MSM.

Further study identified that IL-1Ra was highly expressed in hepatitis B vaccine activated MSM cells. IL-1Ra can inhibit the ability of T cells (Tfh) in B follicles to stimulate B cells to mature and produce antibodies (a process also known as germinal center response of draining lymph nodes). Therefore, the antibody response of hepatitis B vaccine was significantly increased after the macrophages were removed or

>> PAGE 15

[IMAGE: THE EAGLE PROJECT/THE VIRGO CONSORTIUM FOR COSMOLOGICAL SIMULATIONS]

Chinese Academy of Sciences and Durham University hold latest webinar

The partnership between the Chinese Academy of Sciences (CAS) and Durham University in the UK is going from strength-to-strength, as the two organizations launch their latest webinar in a joint series.

From supermassive black holes to the hunt for dark matter, scientists at Durham and CAS are at the forefront of investigations into the evolution of the universe to further our understanding of the cosmos and our place in it.

This research forms the basis of the latest webinar, called "Black Holes, Galaxies and the Evolution of the Universe," which was held on May 18.

Durham's collaboration with CAS covers a wide range of disciplines, including astronomy, cosmology, paleontology and energy.

Within the areas of astronomy and cosmology, the universities' research spans from understanding what happens to material very close to a black hole, to the structure of our universe across cosmic time.

The webinar was delivered by Professor Carlos Frenk, Professor Martin Ward and Professor Chris Done from Durham University, together with Dr. Jin Chichuan, from CAS's National Astronomical Observatories of China (NAOC).

The webinar also included brief speeches from CAS's vice-president, Professor Zhang Yaping, and Durham's vice-chancellor, Professor Stuart Corbridge, and a Q&A session chaired by Durham's deputy executive dean (Faculty of Science), Professor Wu Junjie.

"CAS is the largest research organization in China comprising more than 100 institutes as well as three universities. We attach great importance to international cooperation and we have a long-term partnership with Durham University across a wide range of research fields," said Professor Zhang. "This webinar series is a great example of how we are working together to stimulate new thinking and encourage further collaborations."

The series brings together researchers who are outstanding in their fields of expertise to open up new perspectives across cultures, deepen collaboration and share fresh insights. Previous webinars have featured talks about paleontology and interdisciplinary research.

"We are really proud of our long-standing partnership with the Chinese Academy of Sciences. Both of our organizations are conducting world-changing research by pushing and exploring boundaries and addressing some of the most pressing issues in society today," said Professor Corbridge.

"It is therefore very fitting to have this joint webinar series, as we share common ground. We are both committed to interdisciplinary research that can improve the world and change lives."

>> **PAGE 15**




>> **PAGE 14**

This latest webinar looked at research into the on-going heartbeat of a supermassive black hole found 600 million light years from Earth.

The repeated beat from this cosmic giant is created as the black hole feeds on its surroundings. It was seen again in 2018 — more than 10 years after first being observed. It's the longest-surviving heartbeat ever observed in a black hole and tells us more about the size and structure close to its event horizon — the space surrounding the black hole from which nothing, including light, can escape.

Alongside this, the webinar explored the work of cosmologists who use supercomputer technology to simulate the universe's evolution. Recently, they've used these simulations to zoom in on the smallest clumps of dark matter in a virtual universe. The equivalent to being able to see a flea on the surface of the Moon, this detailed research could help us find the real thing in space.

Source: Durham University

>> **PAGE 13**

the IL-1Ra gene was knocked out from the macrophages. Similarly, mice injected with IL-1Ra blocking antibody, and then immunized with hepatitis B vaccine, not only improved their antibody titer, but were also significantly protected from hepatitis B virus infection. Because MSM is responsible for filtering and clearing large particles of foreign substances in lymph nodes, not only the antibody response of hepatitis B vaccine but also that of inactivated vaccines such as hepatitis A vaccine is also regulated by IL-1Ra.

These findings provide firm evidence that specific macrophages regulate Tfh/B antibody response levels in the lymph nodes by the production of IL-1Ra. The level of IL-1Ra may serve as new diagnostic criteria for the non-responders of hepatitis B vaccine. The findings also provide a new basis for the development of vaccine adjuvants to improve the immunogenicity and protection effect of particle vaccines such as hepatitis B vaccine.

The work was completed by the IPS, the Hou Baidong research group from the Institute of Biophysics (IBP) of CAS, and the Gong Sitang research group of Guangzhou Women and Children's Medical Center. Tang Hong (IPS, CAS), Hou Baidong (IBP, CAS) and Li Shuran are the co-corresponding authors of the paper. Lin Xinwen, the PhD student of Tang Hong's lab (IPS, CAS), and Trix Twelkmeyer, the postdoctoral fellow of the Guangzhou Women and Children's Medical Center, are the co-first authors of the paper.

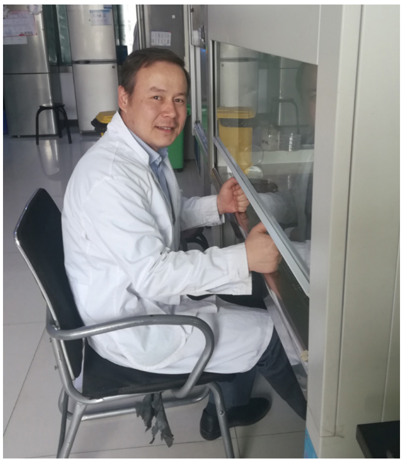
For more information, please contact:

Doctor & Professor Tang Hong
E-mail: htang@ips.ac.cn
Institut Pasteur of Shanghai (IPS), Chinese Academy of Sciences

Source: Institut Pasteur of Shanghai (IPS), Chinese Academy of Sciences

My life and research at Xinjiang Institute of Ecology and Geography

In 2017, when I got the good news of having been awarded the CAS PIFI fellowship at the Xinjiang Institute of Ecology and Geography (XIEG), Chinese Academy of Sciences (CAS), I felt it was an honor to participate in the program. It was a great opportunity to share knowledge and broaden my mind in the fields of ecology, biotechnology and microbiology, the fields where I generally do my research. After finishing my PhD in Germany, I planned to get some postdoc experience abroad. China was one of my target countries to pursue my research, as it offers a great scientific environment. Additionally, it was also a chance to discover the cultural differences in a multi-ethnic China which boasts cultural diversity, art and architecture. I worked in Professor Zhang Daoyuan's group at the XIEG looking at the invasive insect, Agrilus mali, especially its larval stage. This species causes destructive damage of wild apple (Malus sieversii) populations in the Tianshan forests of western China. In the group we determined its molecular phylogeny and life cycle. However, to work with this insect in laboratory conditions, we needed to develop insect rearing. Our developed artificial diet indicated that we could establish this system. The region is a very comfortable place for this invasive insect and it has extensively multiplied. To understand the high adaptability of this insect, we analyzed larvae gut microbiota, and saw that microbial diversity differed with another individual of the same species from Central China. Within two years I had published two first author papers and another one is ongoing.



The research atmosphere in our group where I did my research is very friendly and helpful. In particular, young Chinese scientists and students work hard. Young students work on their topics with great enthusiasm. Here I would like to thank Professor Daoyuan and all of the lab members who helped and supported me from the start to settle in very quickly. Often, because of language barriers, lab members helped me with documentations. A friendly and welcome environment made me feel very at ease in the group.

Urumqi is a city where our institute is located, where a mix of different cultures can be seen. I visited different places in the city and came to know that they are really beautiful, and are must-see places for newcomers. Culturally, Chinese cuisine is also diverse, and I like all of the different types. For the first time, I experienced "hotpot" restaurants, and it was a whole new restaurant world. I am sure I will miss this kind of hotpot restaurant in my country.

In 2019 I attended a "Belt and Road" conference in Beijing dedicated to different scientific fields. It was impressive, and a good chance to spread scientific knowledge. Additionally, I was very impressed by the city, especially during our visit to the Forbidden City. Our hotel was located near to the National Stadium, also known as the Bird's Nest, and that gave me a chance to visit it. In December 2019 we visited Northwest China's Ningxia Hui Autonomous Region, to the central city Yinchuan for a workshop on desertification. We were taken to the sandy desert in this region where we saw how China struggles against desertification by planting plants with drip irrigation systems.

It was a great experience for me to work and live in China. All my memories of China are very positive. I recommend scientists apply for the CAS PIFI fellowship. I am very grateful to CAS for providing me with the opportunity to do research in China, and to Professor Zhang Daoyuan and Professor Zhang Yuanmin for mentoring me, providing guidance and hosting me during my fellowship.

Source: Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences

3,718 new species recorded in Yunnan over past 30 years

A total of 3,718 new or newly recorded species were discovered in Southwest China's Yunnan Province between 1992-2020, according to a press conference held in Kunming, the provincial capital, on May 22.

The statistics were included in the *Checklist of New and Newly Recorded Species in Yunnan (1992-2020)*, which was released at the 2021 International Biodiversity Day press conference, hosted by the Department of Ecology and Environment of Yunnan Province.

The *Checklist of New and Newly Recorded Species in Yunnan (1992-2020)* was issued to welcome the forthcoming 15th meeting of the Conference of the Parties to the Convention on Biological Diversity (COP15) to be held in Kunming in October. It was jointly completed by researchers from the Department of Ecology and Environment of Yunnan Province, Xishuangbanna Tropical Botanical Garden (XTBG) of the Chinese Academy of Sciences (CAS), with the support of the Kunming Institute of Botany (KIB) of CAS, the Kunming Institute of Zoology (KIZ) of CAS, Southwest Forestry University and other institutions.

According to the *Checklist*, a total of 3,718 species (2,519 new species and 1,199 newly recorded species) have been discovered in Yunnan Province, including macrofungi, lichens, moss, ferns, gymnosperms, angiosperms, fish, amphibians, reptiles, birds, and mammals.

A kind of lichen [IMAGE: MA WENZHANG]

A newly found ginger species [IMAGE: TAN YUNHONG]

Primulazhui [IMAGE: DING HONGBO]

A newly found rhododendron species [IMAGE: DENG QIANG]

New genus *Tsaiodendron* found in central Yunnan [IMAGE: TAN YUNHONG]

New reptile species found in Yunnan [IMAGE: YANG TAO]

In terms of the distribution area, the new and newly recorded species were mainly found in Gongshan County, Nujiang Lisu Autonomous Prefecture and Mengla County, Xishuangbanna Dai Autonomous Prefecture.

The biodiversity survey data are relatively weak in central Yunnan. "The new genus *Tsaiodendron*, which was named in honor of XTBG founder Cai Xitao, had not been found and published until 2017," said Tan Yunhong of XTBG.

The mid-1990s and the past 10 years were the peak period for the discovery of new and newly recorded species. More than 200 species were discovered or newly recorded in both 2016 and 2020.

>> **PAGE 19**

China's technological research capabilities see steady growth

The common method of patent layout analysis is to use the patent classification system (IPC/CPC) for statistical analysis, but not for analysis of industrial technology fields. And classical citation co-occurrence analysis has shortcomings too.

A research team from the Institutes of Science and Development of the Chinese Academy of Sciences (CASISD) has developed a more scientific and reasonable method for technology structure discovery.

The purpose of the report is to describe the current global technological landscape, enabling experts and policymakers to intuitively observe the development trends of frontier technologies and allow science and technology to better serve the economy objectively and thoroughly, said Professor Pan Jiaofeng, President of CASISD.

According to the reports "2021 Technology Focus" and "Mapping Technology Structure 2021", both released on June 4, the researchers used deep learning models to learn the characteristics of patent texts. They then trained a dedicated patent text feature extraction model, and used it as a basis to draw a panoramic patent structure map and form a patent technology hotspot database.

Among the 7,375 technology focuses in 32 areas of the four technology divisions of electrical engineering, instrumentation, chemistry, and mechanical engineering given by the World Intellectual Property Organization (WIPO), the "2021 Technology Focus" report selects the top 100 technology focuses, based on data from the World Technology Focus database, and provides detailed interpretation of certain key technology focuses.

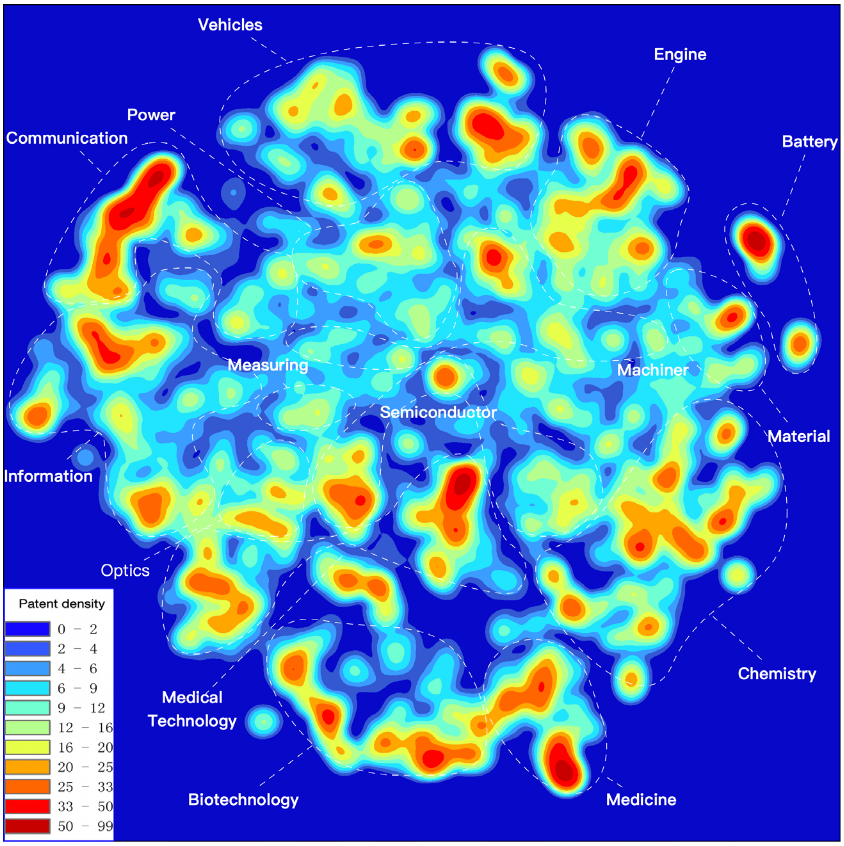


Fig. 1 Mapping technology structure: the larger the number of patents, the greater the density and the brighter the color; on the contrary, the smaller the number of patents, the lower the density and the darker the color. Technology focus areas are circled based on density contours, and these areas are identified by their technology focuses which is helpful for the understanding of the technology structure. [IMAGE: CASISD]

From Fig. 1 we can see that at the top of the map are four technology focuses: vehicles, engines, power, and communication. On the left, there are three technology focuses: information, measuring, and optics. On the right, there are three technology focuses: materials, batteries, and chemistry. At the bottom, there are three technology focuses: medical technology, biotechnology, and medicine. In the middle, there are two technology focuses: machinery and semiconductors.

It can be seen from the technology structure map that the world's triadic patents are centered on three industries of information and communication technology (ICT), medical devices and pharmaceuticals, and automobiles and other vehicles. Other major industries also include chemical engineering, metallurgy and equipment manufacturing. Most technology focuses are located in very concentrated areas, while the technology focuses of semiconductors, medical technology, and machinery in the middle of the map are seen with several obvious sub-focuses (See Fig. 1).

>> PAGE 19

>> **PAGE 18**

This study suggests that China's technological research capabilities have seen a steady growth from 2014 to 2019, by contributing 12,284 (4.5 percent) of the global total number of "triadic patents" within this period.

Professor Wang Xiaomei, a researcher from the institutes and one of the key authors of the report, said that China is the only country among the world's top six holders of triadic patents that is still experiencing relatively fast growth in this field. "However, creating more high-quality patents is one of the major challenges for China", she said.

From 2014 to 2019, China ranked fourth in the world in terms of the total number of triadic patents, with communication and information technology being the nation's most technologically advantageous field.

Meanwhile, China is noticeably behind, both in the diversity and total number of triadic patents, compared with other technological powerhouses such as Japan, the United States and Germany. For instance, Japan held 91,618 such patents from 2014 to 2019, followed by the United States with 71,658 and Germany with 20,793.

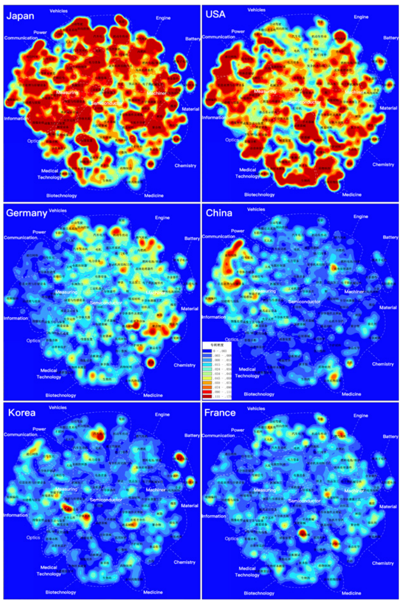


Fig. 2 Six nations' triadic patent share overlay maps show the share of triadic patents of six countries in different technological focuses. The brighter the color, the higher the share. [IMAGE: CASISD]

"Medical technologies, biomaterials, machine tools and engine design are technological fields featuring high-quality patents in which China needs considerable improvement to catch up with other major economies," said Professor Wang.

So far, CASISD has formed a series of scientific and technological think tank outputs, such as "Research Fronts" and "Mapping Science Structure" based on the analysis of high impact papers, and "Technology Focus" and "Mapping Technology Structure" based on the analysis of high value patents.

From the perspective of the overall technology focus layout, Japan and the United States have absolute advantages in both the number of triadic patents and the coverage of technology focuses, with the share of triadic patents in each technology field exceeding 10 percent. Japan and the United States are also complementary in the technologically advantageous fields at the top and bottom of the map, with Japan having obvious advantages in the vehicles technology on the top of the map and the United States showing advantages in medicine and medical treatment at the bottom of the map. China and Germany have obvious advantages in communication and computer technology as well as in chemical engineering and mechanical engineering respectively on the left and right of the map. In addition, France and Germany have similarities in the shares of technology fields of the World Intellectual Property Organization (See Fig. 2).

Source: Institutes of Science and Development, Chinese Academy of Sciences

---

>> **PAGE 17**

Over the past 30 years, more than one-third of the new species in China have been discovered in Yunnan, making it the place where the most new species are being recorded.

"The *Checklist* is a reflection of Yunnan's great contribution to biodiversity conservation research and lays a foundation for further strengthening species protection, guiding the rational development and utilization of biological resources, and providing data support for real-time updates to the biological species checklist and its red list in Yunnan," said officials of Yunnan at the press conference.

Meanwhile, the *Checklist* also enriches public understanding of biodiversity, which is of positive significance in terms of increasing public awareness and correctly gauging the status quo of biodiversity in Yunnan.

"Taking the release of the *Checklist of New and Newly Recorded Species in Yunnan (1992-2020)* as a new starting point, we'll work collaboratively and contribute more to new species discovery and biodiversity conservation," said Yang Yongping of XTBG.

Source: Xishuangbanna Tropical Botanical Garden (XTBG), Chinese Academy of Sciences