

Into the unknown

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CHINA

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Telescope set to unravel cosmic mysteries

New facility may help provide answers to some of the biggest questions astronomers have long been asking about the universe. Xinhua reports.

The Chinese Survey Space Telescope, also known as the Chinese Space Station Telescope or the Xuntian Space Telescope, is a space-based optical observatory that will allow astronomers to conduct surveys by capturing a general map or images of the sky.

The CSST is a bus-sized facility, whose length is equal to that of a three-story building. Although it has an aperture of 2 meters, a little smaller than the Hubble Space Telescope, its field of view is 350 times larger than Hubble's, according to Liu Jifeng, deputy director at the National Astronomical Observatories of China.

Li Ran, a project scientist at the CSST Scientific Data Reduction System, said, "The field of view is the area of the sky a telescope can see at one time."

Hubble's field of view is approximately 1 percent of the size of a fingernail at an arm's length, thereby the telescope observed only a tiny fraction of the sky, Li added.

The CSST, which is still under construction, has a three-mirror anastigmat design that helps it achieve superior image quality within a large field of view, according to the researchers.

Moreover, it is a Cook-type, off-axis telescope without obstruction that can, in principle, achieve high precision in photometry, position and shape measurements when properly sampled.

"It has an advantage for survey observations since it can scan a large part of the universe fairly quickly," said Zhan Hu, a project scientist at the CSST Optical Facility.

Special equipment

The telescope will be equipped with five instruments, including a survey camera. The main focal plane of the camera is equipped with 30 91-megapixel detectors that will take images and spectra of roughly 17,500 square degrees of the median-to-high galactic latitude and median-to-high ecliptic latitude sky in multiple bands, the researchers said.

Four other instruments mounted on the CSST have been designed to observe individual objects or small fields, such as mapping star-forming regions of the Milky Way, obtaining instantaneous colors of fast-varying objects such as comets and spinning asteroids, studying the coevolution of supermassive black holes and galaxies and star formation in the nearby part of the universe, and direct imaging of exoplanets in the visible range.

The CSST is likely to be the largest space telescope for astronomy in the near-ultraviolet and visible range in the decade before 2025.

To explain the CSST's capabilities, Li used the analogy of photographing a flock of sheep.

"Hubble may see a sheep, but the CSST sees thousands, all at the same resolution," he said.

Shared orbit

During its normal observations, the telescope will fly independently in the same orbit as China's space

station, but at a great distance apart. The in-orbit construction of the space station is expected to be completed this year.

Zhan said the telescope was initially designed to be mounted on the space station, but there would have been disadvantages such as vibration, potential contamination, stray light and line-of-sight obstruction caused by the space station's proximity.

As a result, a new design was adopted, putting the telescope in the orbit of the space station but keeping them far from each other during normal operations.

However, the CSST will dock with the space station for refueling and servicing — either as scheduled or whenever necessary — making its maintenance more affordable than Hubble's.

From 1993 to 2009, NASA launched space shuttles on five servicing missions for Hubble to undertake repairs, replace parts and install new instruments.

The CSST, which is expected to start scientific operations in 2024, has a nominal mission life of 10 years, but in principle, that could be extended.

The telescope will take pictures of 40 percent of the sky and transmit massive amounts of data back to Earth, which scientists across the world will be able to study, Li said, adding that its main objective is to address the most basic questions about the universe.

It will observe well over 1 billion galaxies and measure their positions, shapes and brightness, which may help explain how those galaxies evolved.

"We know that our universe is expanding with an acceleration, and we can calculate its current expansion rate, but it's still unknown what causes the acceleration," Li said. "CSST observations may offer answers and unveil new physics."

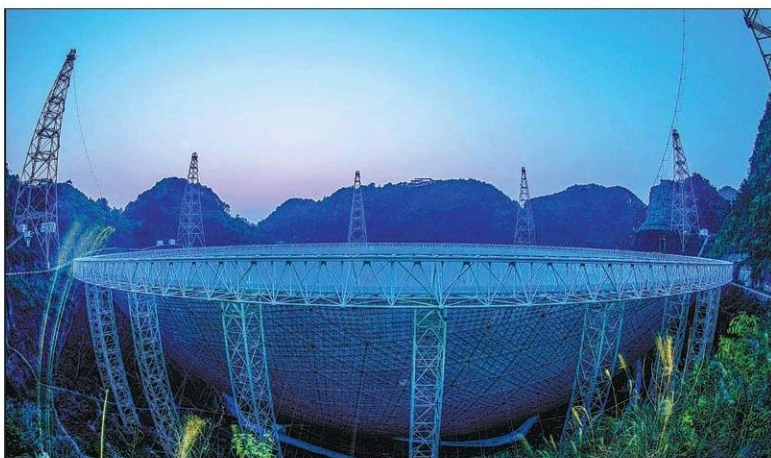
The telescope will also be able to help determine the upper limit of neutrino mass and shed light on the mysterious phenomena of dark matter and dark energy. They are believed to account for the majority of the universe's mass-energy content.

Further studies

The versatile telescope will undertake many more intriguing studies, such as drawing a galactic dust map of the Milky Way, observing how supermassive black holes are gobbling up surrounding materials, exploring exoplanets and discovering unusual new celestial bodies.

"The orbital period of Uranus is more than 80 years. Hubble has been unable to observe Uranus. The CSST could continue the work to examine how Uranus moves in one complete period," Li said.

"The telescope can bring China's research in optical astronomy to the forefront of the world and help cultivate world-class Chinese scientists. It can also take breathtaking visible pictures, allowing the public to directly feel and understand the universe."



A view of the Five-hundred-meter Aperture Spherical Telescope in Pingtang, Guizhou province. A amateur astronomer have given the facility the nickname *Tianyan*, or "The Eye of Heaven". OU DONGQU / XINHUA



Clockwise from above: A maintenance crew works on *Tianyan*. OU DONGQU / XINHUA
Zhai Zhigang, a member of the Shenzhou XIII crew, waves during a spacewalk in November. GUO ZHONGHENG / XINHUA
Workers perform maintenance work on high-altitude cosmic ray wide-angle observatory telescopes in Beijing. JIN LIWANG / XINHUA



Space technology comes right down to Earth

By ZHANG YANGFEI

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More than 4,000 technologies developed for China's manned space program have been widely applied across a number of sectors. For example, space breeding technology alone has generated more than 200 billion yuan (\$30 billion) so far, officials said.

Last month, Hao Chun, director of China's Manned Space Agency, told a news briefing that the nation's manned space program is a great cause that is "both lofty and down to earth." He added that its evolution can drive upgrades of related industries and promote great socioeconomic development.

In the 30 years that China's manned space program has been active, more than 4,000 technological achievements have been widely used, driving innovation in sectors such as raw materials, microelectronics, machine manufacturing and communications.

For example, the space breeding technology has not only promoted

crop improvements, but has also been employed in fields such as food processing and the cultivation of bacteria and biopharmaceuticals. As such, it has generated economic benefits and contributed to food security and environmental protection.

Hao said manned space flight is an activity that features the most complex systems, the most intensive achievements and the most dynamic innovations.

For example, the heat control systems of liquid-propellant rocket engines can be used to upgrade the gasification of pressurized pulverized coal combustion, solve problems related to domestic waste disposal and improve the performance of hydrogen fuel cells.

Moreover, the research and development processes for technologies related to controls, measurements, image processing and other components used in rockets, spacecraft and space stations can promote the upgrading of intelligent industrial control systems.

The heat-resistant base technology of manned spacecraft has been

used to make heat insulation materials for civilian use. The recent Winter Olympics in Beijing also adopted a large number of aerospace technologies for use in the opening and closing ceremonies, as well as in athletes' training equipment.

A large number of space technologies have also been adapted for civil use, such as instant food and daily necessities including diapers, while space protein crystallization is being researched to help develop new drugs to treat osteoporosis and muscular dystrophy.

Furthermore, manned space environmental control and life-support technology, and research into microgravity combustion mechanisms and new materials research can also be translated into a range of fields related to livelihoods and deliver more benefits, according to Hao.

"In the future, the Chinese space station will conduct a large number of experiments in space life science, space materials research, microgravity fluid physics and space medicine, which are expected to achieve significant results and break

through in scientific exploration and applied research," he said.

"We believe that these technologies will be adopted more frequently to serve socioeconomic development, the national economy and people's livelihoods."

Space technologies have served daily life throughout the global history of space exploration.

The commercialization of adult diapers was rapidly promoted in the 1960s after NASA astronaut Alan Shepard reportedly had to urinate in his space suit while awaiting the launch of Freedom 7 in 1961.

The air cushion shoe was derived from a process known as "blow rubber molding" used by NASA to create the spacesuit. In 1979, Frank Rudy, a NASA employee, came up with an idea of using this sealed cushioning system as the midsole of shoes and pitched it to Nike Inc.

That pitch resulted in the birth of Nike Air, one of the company's bestselling lines. Freeze-dried food is also a regular item in diets today, thanks to space technology. In the early days of the



Astronaut Wang Yaping, a member of the Shenzhou XIII crew, delivers a lecture from the Tiangong space station to students in Macao in December. ZHANG JINJIA / XINHUA

United States' manned space program, a key problem was ensuring that the astronauts could be fed while in orbit. As a result, NASA funded research on an array of possible food-preservation techniques.

The freeze-dried technique removed the water content of fruit and vegetables while retaining the nutrients.

The technique not only helped enrich the astronauts' cuisine, but

was also applied to daily food storage in the civilian world.

Many more common features of daily life originated in space technologies.

From smoke detectors, computed tomography and magnetic resonance imaging in hospitals to solar panels, fiber-optic cables and bar codes, people are enjoying the convenience brought by these space-based technologies every day.