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Study based on FAST findings may be historic

By ZHANG ZHIHAO
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An international team of scientists led by Chinese astronomers has found that magnetic fields cannot hold off gravitational collapse in the early stages of star formation as scientists previously believed, according to a study to be published in the journal Nature on Thursday.

The discovery has challenged the standard theory of star formation, and experts have encouraged international peers to use the newly published observational technique and come up with new theories to explain how stars are born.

The research was done using the Five-hundred-meter Aperture Spherical Telescope, the world's largest radio telescope, located in southwestern China's Guizhou province.

The study, which is featured on the cover of Nature, is considered one of the biggest scientific discoveries made by the radio telescope to date.

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Study: Over 120 published papers based on FAST data

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In the standard theory of star formation, scientists believed pressure created by magnetic fields could influence the formation of stars because they allow interstellar material to resist the force of gravity, thus making it harder for the material to gather enough mass to collapse into a star.

However, studying this interaction has proved to be extremely difficult because such interplay between magnetic fields and matter is notoriously complex and difficult to detect.

Li Di, FAST's chief scientist and the corresponding author of the study, said by taking advantage of the unparalleled sensitivity of the giant telescope, scientists measured the strength of the magnetic fields in the L1544 region, a pre-stellar core in early transition into becoming a star located in the Taurus star forming regions about 450 light years from Earth.

Using an observational technique called HI Narrow Self-Absorption, first conceived by Li and United States astronomer Paul Goldsmith in 2003, scientists discovered that the magnetic pressure was too weak to prevent gravitational contraction at this early stage of the process, a finding that contradicts the standard theory of star formation.

"This discovery has challenged our traditional understanding of the role magnetic fields can play during star formation," Li said. "Our work represents the feasibility and the beginning of using this new technique to study the magnetic fields of the interstellar medium during early phases of star formation."

Richard Crutcher, emeritus professor of astronomy at the University of Illinois, who was not involved in the study, said he was "very impressed" with the talent and engineering behind FAST, which resulted in this groundbreaking discovery.

Crutcher said the discovery was "crucial to understanding the astrophysics of star formation and illustrates the importance of FAST in addressing important unsolved astrophysical problems".

Jiang Peng, chief engineer of FAST, said the telescope recorded 5,308 hours of observation time last year and collected over 11 petabytes of scientific data, making it one of China's most productive major scientific instruments.

Since the telescope's completion in 2016, scientists have published over 120 papers based on data it collected, including four studies in the journal Nature, he said. "FAST has entered a stage of producing high-quality major scientific achievements," he added.

On March 31, FAST was open to research proposals worldwide. Twenty-seven projects from 14 foreign countries have been approved so far and their scientific observation began in August, Jiang said.

FAST has also discovered around 500 pulsars — highly magnetized, fast-spinning neutron stars originating from the imploded cores of massive dying stars through supernova explosions, Jiang said.

Wu Xiangping, a noted astronomer and an academician of the Chinese Academy of Sciences, said that pulsars have been a hot topic in astrophysics given their extreme density, brightness and rotational stability, which allows scientists to measure subtle celestial abnormalities such as gravitational waves.

A major discovery would be a binary system in which a pulsar rotates around a black hole, Wu said. The interaction between these two extreme celestial bodies may enable scientists to test the finer details of Einstein's theory of gravity with unprecedented precision.

"FAST is already exceptionally good at finding pulsars," he said. "But if we can collaborate with other telescopes around the globe, we can detect more pulsars that are fainter and further away from us, and maybe even find ones that are outside of our home galaxy."

Leading contractor plans more than 40 space launches

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China Aerospace Science and Technology Corp, the country's major space contractor, plans to carry out more than 40 space launch missions this year, according to its annual work report.

Among the scheduled launches, the most important ones will be the six related to the Tiangong space station program, according to the report delivered by Xu Qiang, general manager of the State-owned space conglomerate, at the company's annual work conference on Tuesday.

The six launches will be used to deploy the Shenzhou XIV and XV mission crews to the Tiangong station, which is circling the Earth in a 400-kilometer-high orbit; to transport the Tianzhou 4 and 5 robotic cargo spaceships to the station for refueling and resupply operations; and to deliver two large space labs to dock with Tiangong, the report said.

Mission planners at CASC have said that of the six spacecraft, the first to be launched will be the Tianzhou 4, followed by the Shenzhou XIV manned spacecraft. Then the two space labs — Wentian, or "Quest for Heavens", and Mengtian, or "Dreaming of Heavens" — will be lifted to complete the Tiangong station. The Tianzhou 5 will be the fifth, and the final one will be the Shenzhou XV.

Pang Zhihao, a spaceflight researcher in Beijing who worked at the China Academy of Space Technology for decades, said that the government is determined to complete the in-orbit construction of Tiangong before the end of this year, so CASC must make sure that all of the six launches will be successful and on schedule.

55
orbital launches
were conducted by China in 2021, the most in the world.

Currently, Tiangong is occupied by the Shenzhou XIII mission crew — Major General Zhai Zhigang, Senior Colonel Wang Yaping and Senior Colonel Ye Guangfu — who arrived at the station in mid-October and are scheduled to stay there for six months.

Last year, CASC carried out 48 launch missions with its Long March rockets, which are the nation's pillar space transporters. All of the missions were successful, making Long March the world's busiest launch vehicle family last year.

China conducted 55 orbital launches in 2021, more than any other country. The United States performed 51 launches last year, second in liftoffs.

In another development, CASC also plans to conduct the maiden flight of its Long March 6A rocket this year, according to the work report.

Designers said the medium-lift Long March 6A will consist of a 50-meter, liquid-propelled core booster and four solid-fuel side boosters. It will be tasked with transporting satellites to multiple types of orbit including sun-synchronous, low-Earth or intermediate circular orbit.

The rocket, developed by the company's Shanghai Academy of Spaceflight Technology, will have a liftoff weight of 530 metric tons. Its core booster will have a diameter of 3.35 meters and will be propelled by two 120-ton-thrust engines burning liquid oxygen and kerosene.