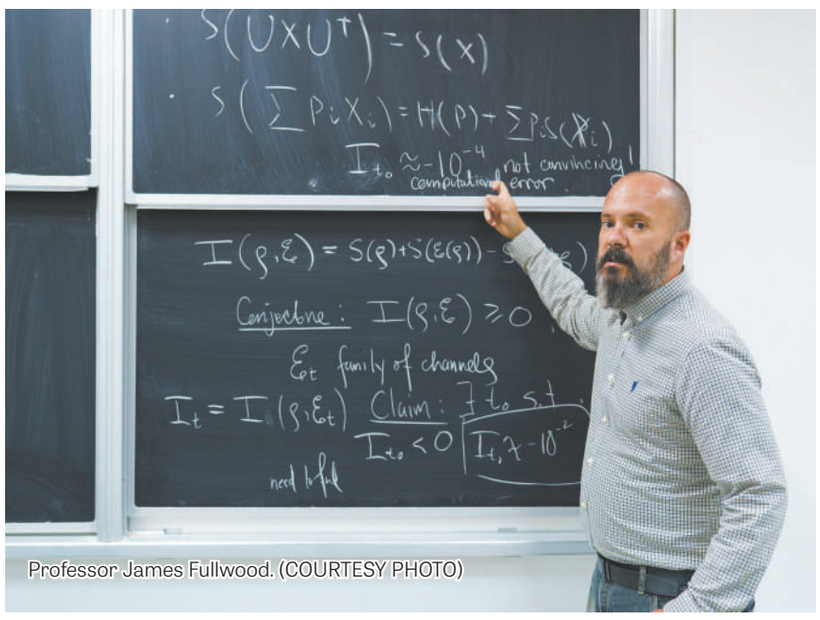
Finding 'Innovation Oasis' for Fundamental Physics

Dialogue

By WANG Zhuhua & SHEN Jie



Professor James Fullwood. (COURTESY PHOTO)

James Fullwood first came to China nearly 14 years ago. As a PhD student he collaborated with Fields Medalist Shing-Tung Yau on the geometry of string theory, and then took a postdoctoral position at The University of Hong Kong under Chinese Academician Ngaiming Mok. But it was a 2020 visit to Hainan University in south China that sealed his destiny. "I am originally from Miami, Florida, and I immediately felt at home with Haikou's blue skies, clean air and tropical climate." In April 2024, he joined the faculty of the School of Mathematics and Statistics, finding an idyllic atmosphere for his research on fundamental physics.

Landing on a familiar shore

"I am very satisfied with my decision," Fullwood says. "I have an idyllic atmosphere in which to carry out my research on fundamental physics, and the university has been very supportive of my academic endeavors every step of the way."

His move also reflects a broader conviction about where science is headed.

At Hainan University, he found a system built on trust."The thing that I enjoy most is the autonomy I have in conducting research projects. As long as I continue to publish in top-tier journals at a consistent rate and acquire funding, I have the freedom to explore wherever it is that my mind takes me."

The academic staff, he adds, is always helpful and accommodating, which he sees as crucial for a foreigner in China.

Teaching has grown into a two-way street of cultural discovery. While his students polish their academic English and absorb international teaching styles, Fullwood learns from their disciplined problem-solving and fresh perspectives on mathematics. "My classroom serves as a vibrant laboratory for cross-cultural integration. I am constantly learning."

The small moments matter: a student explaining a local custom during a break, a colleague sharing insight into the local academic landscape. "This ongoing dialogue has built a bridge of mutual respect and shared purpose, proving that fundamental science is a universal language that transcends all borders."

Beyond spacetime

Fullwood's research is driven by the "It from Qubit" paradigm, the foundational concept in theoretical physics proposing that all physical reality — matter, energy, space, and time — is not made of fundamental, solid "stuff," but emerges from the processing of quantum information.

"Spacetime is like the screen of your phone, an interface for completing tasks such as sending a text message. However, what's really happening takes place inside the transistors and microchips on the motherboard of the phone, which is the analog of the quantum realm." Two icons may sit at a certain distance on the screen, but inside the motherboard, there is no such distance. "And so it is with space and time. At the quantum level there is only information: It from qubit."

A central challenge over the past five years has been to fix a deep asymmetry in standard quantum theory. Space and time are treated differently: Spatial correlations are encoded in quantum states, but temporal correlations are handled case by case without such states. "This is a fundamental asymmetry which is at odds with the fundamental premise of relativity, which treats space and time on equal footing."

He and his collaborators derived what a "temporal quantum state" must be from simple mathematical assumptions, much as Einstein derived Special Relativity from the constancy of the speed of light and the equivalence of inertial frames. The work has shed new light on time-reversal symmetry, quasi-probability, quantum Bayesian inference, and state collapse upon measurement, and was published in *Physical Review Letters*.

Asked about breakthrough moments, Fullwood is measured. "Progress in science is often slow, and comes in little bits and pieces. Over time those bits and pieces come together and start to form something substantial." And there is a paradox he lives with: The more he knows, the more he knows he doesn't know. Still, the gradual deepening of understanding makes the effort worthwhile.

An open, free trade port

Island-wide special customs operations and free trade port policies have reshaped the logistics of scientific exchange in Hainan. Fullwood points to the 30-day visa-free policy. "This 'zero-friction' mobility is a significant competitive advantage for international cooperation. By removing the administrative burden of embassy and consulate visits, we can invite world-class collaborators and speakers with the same ease as arranging a domestic visit." Smoother channels for importing research equipment add to the effect, turning Hainan into what he calls an "innovation oasis."

To friends back home, he describes Hainan as a "tropical Silicon Valley," with Hainan University as the academic heart of the transformation. He tells them about the blend of cutting-edge research and the vibrant, welcoming environment. For international talents considering a move, his advice is straightforward. "Arrive with a spirit of radical openness and curiosity." The university's support, he says, is designed to let scholars focus on research and teaching. "By being patient and adaptable, you will find a remarkably hospitable environment that is eager to integrate global expertise into its ambitious vision for the future."

His own expectations are simple. Asked for three words that capture Hainan University and the Hainan Free Trade Port for him, he says: "Opportunity. Vision. Support." Then he adds a fourth — "Bright." That's the future of Hainan University.

Tech+Culture

Tech Behind 'Health Check Report' of Great Wild Goose Pagoda

By Staff Reporters

After nearly a year of systematic surveys, the Great Wild Goose Pagoda in Xi'an in northwest China received its first-ever "full-body health check report." This square, pavilion-style brick pagoda dating from the Tang Dynasty (618-907) has stood for over 1,300 years. For the first time, its internal structure has been clearly revealed through a 3D model.

The report reveals the pagoda's multi-layered, composite structure and systematically assesses risks such as weathering, water damage, and vibration. It also proposes scientifically grounded conservation recommendations.

An ancient pagoda under CT scan

The project to survey the structure of the Great Wild Goose Pagoda and assess its stability was launched in July 2025. The project team established an integrated detection system. Satellite remote sensing revealed an average subsidence rate of merely 1.76 millimeters within a 100-meter radius of the pagoda over the past three years, indicating overall stability. Drone-based oblique photogrammetry and dense matching algorithms were employed to reconstruct a 3D model with millimeter-level resolution, making every brick crack and instance of mortar crumbling clearly discernible.

"Every material has a unique electromagnetic resonance frequency, much like a human fingerprint," explained project leader Miao Yuanyao. By emitting electromagnetic waves at specific frequencies, the technology can clearly identify material composition and layered structures, as well as detect hidden defects, such as voids and cracks, without causing any damage to the structure. The pagoda's complex structural composition was uncovered for the first time: a rammed-earth core, Tang Dynasty brick masonry, Ming Dynasty (1368-1644) brickwork repairs, and a timber column support system.

Deciphering the 'medical history' hidden in brick joints

Identifying visible signs of damage was the first step. Understanding the underlying causes is equally crucial. Professor Fu Qiang from Xi'an University of Architecture and Technology revealed the microscopic mechanisms behind this deterioration.

Samples taken from the areas where the pagoda's structure was crumbling showed that salt concentrations in the severely weathered zones were dozens of times higher than in unweathered bricks. The soluble salts migrate within the bricks alongside moisture, repeatedly crystallizing and dissolving. This process acts like a microscopic chisel, gradually disintegrating the brick structure.

"Soluble salts are the direct trigger for surface deterioration," Professor Fu said.

Winter freeze-thaw cycles and salt erosion create a synergistic effect as well. Laboratory simulations demonstrated that the combined pressure from expanding ice crystals and salt crystallization produces cumulative damage greater than the sum of its parts. Using non-destructive microwave testing, the team mapped the pagoda's moisture distribution.

"Moisture is the primary factor driving the deterioration of ancient brick pagodas," the report stated. Sun Qi, deputy director of the Great Wild Goose Pagoda Preservation Office, added, "In recent years, precipitation has been the main factor destroying the pagoda."

Combating invisible enemies

In addition to weathering and moisture-related issues, the pagoda is threatened by two invisible enemies: long-term, low-frequency environmental vibrations and sudden, transient seismic forces.

To address these risks, the team has made the following recommendations:

- Establishing a three-tiered health monitoring system that covers the global, local, and micro scales;
- Implementing visitor management strategies that combine flow limits, time-slot scheduling, and off-peak access; and
- Conducting specialized maintenance, such as targeted desalination, weathering prevention, and crack repair.

This "health check report," which embodies multidisciplinary expertise, provides a scientific foundation for the preventive conservation of the Great Wild Goose Pagoda and establishes a new paradigm for the systematic study of ancient masonry pagodas in China.

Why AI Is Always 'Thirsty'

Science Outreach

By CHEN Jie & BI Weizi

"Chatting with AI for five minutes consumes approximately 500 milliliters of water." Wu Xuchu, vice chairman of KPMG China, recently revealed this statistic, shedding light on the "other side" of AI.

The entire AI value chain — spanning chip manufacturing, power generation, and computing infrastructure operations — consumes 23 billion cubic meters of fresh water annually.

It turns out that AI is not just an electricity guzzler but also a water drain.

To understand why AI consumes water, one must first understand why it gets "thirsty." Simply put, the "brain" of AI consists of chips — specifically CPUs and GPUs. We can visualize these chips as incredibly intricate "electronic sandboxes." Training an AI or prompting it to answer questions essentially involves issuing countless instructions to these chips. At a microscopic level, this means the transistors inside the chips must switch on and off billions of times per second.

"When electric current flows through a conductor, it generates heat — a thermal effect that is unavoidable in chips. This is especially true for modern large-scale AI models, which often feature hundreds of billions of parameters and require exponentially increasing amounts of computing power," said Wang Libang, a PhD researcher at the Institute of Physics, Chinese Academy of Sciences. In short, the greater the computing power of an AI chip, the higher its power consumption and the more waste heat it produces.

In the early days, data centers relied on massive air-conditioning fans to pump in cool air. However, as the density of AI computing power has increased, air cooling has been pushed to its limits; air has a low heat capacity, meaning the rate at which it carries away heat cannot keep pace with the speed at which the chips generate it. Consequently, engineers devised a more efficient solution — "drinking water," known today as liquid cooling technology.

Wang says the specific heat capacity of water — the amount of heat absorbed or released when the temperature of a unit mass of a substance rises or falls — is more than four times that of air; thus, its ability to dissipate heat far surpasses that of air cooling.

While liquid cooling is effective, it consumes vast quantities of water. In some water-scarce regions, competition between data centers and the agricultural sector for water resources has sparked social controversy.

Faced with these challenges regarding energy and water consumption, the tech industry is already seeking alternative "cooling solutions" for AI.

The first strategy is to leverage the natural environment. Since AI is sensitive to heat, one solution is to relocate to cooler regions. Tech giants like Google and Facebook have built data centers in the Arctic Circle, where the cold air cools the servers naturally. Some Chinese companies have submerged their servers in the ocean to take advantage of the cold seawater.

The second strategy is to put AI on a "diet." Since larger AI models are prone to resource waste, scientists are exploring ways to make AI "smarter" rather than simply "bigger." A research team at Peking University developed a medium-scale inference model that achieves the full performance of mainstream large models using only five percent of the parameter count, thereby fundamentally reducing both water and electricity consumption.

The third strategy is to turn waste into a resource. Innovative projects in Europe have begun channeling waste heat generated by data centers into municipal district heating systems to warm residential buildings. Although this technology faces challenges regarding transmission losses and infrastructure retrofitting, it points toward the future: transforming AI from a mere "major energy consumer" into an integral part of the energy cycle.

As AI technology continues its rapid advance, it is time for us to tally the environmental costs behind every human-AI interaction. As for the future of AI, the competition hinges not only on intelligence but also on an environmentally friendly "emotional intelligence." Only when green becomes the fundamental characteristic of every chip and data center can we secure an intelligent, sustainable future.

China Contributes to Global AI Governance

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Cumulative global downloads of its open-source models have surpassed 10 billion. Chinese large models such as DeepSeek are facilitating the spread of AI technology to more countries through their low cost and high performance advantages.

These pragmatic measures, translating AI development outcomes into practical applications in developing countries, will drive the inclusive and universal development of AI.

Providing global public goods

Transitioning from a participant in AI development to a major contributor to global governance public goods, China continues to offer its solutions for advancing international AI cooperation.

On July 16, the signing ceremony for an agreement to establish the World AI Cooperation Organization (WAICO) was held in Shanghai, with 29 countries from Asia, Africa, Latin America, and Europe as its founding members.

The WAICO will focus on three key aspects: It will promote the accessibility of AI technologies and services through policy exchanges, technical cooperation, personnel training, and joint research, releasing AI dividends to ensure that developing countries benefit from AI.

It will serve as a platform for matching supply and demand, promoting the deep integration and complementarity of national resources, strengthening scientific and industrial cooperation, encouraging co-building an open-source ecosystem, and delivering tangible cooperative outcomes.

It will support a stronger role for the UN, implementing the Global Digital Compact and the UN Sustainable Development Goals.

Gold and Silver Inlay, Early Symbol of Chinese Pictorial Art

Traditional Eastern Wisdom

By DU Xuanyi & ZHONG Jianli

China has over 4,000 years of bronze history perfecting numerous kinds of craftsmanship. One of them is *Cuo Jin Yin*, or gold and silver inlay, a traditional bronze decorative technique which originated in the Spring and Autumn period (770-476 BCE) and reached its peak from the middle and late Warring States period (475-221 BCE) through the Western Han dynasty (202 BCE-8 CE).

The inlay starts with pre-casting shallow grooves on the bronze surface on which the inlay is to be done. Then craftsmen insert thin strips of gold or silver (or wires) into the grooves and chisel the edges to refine the grooves. This is followed by hammering the strips or wires, so that they become deformed and fill the grooves. The last step is polishing, using sand-paper to burnish the bronze surface so that different gloss effects create protruding colorful motifs or inscriptions.

The *Cuo Jin Yin* technique rose not only due to the widespread use of ironware but also the emergence of intellectual creativity. As civilizations progressed, their material cultures flourished and new aesthetics were born.

Among various inlaid gold and silver motifs on bronze, the extant Chinese pictorial art was created. Craftsmen needed to inlay motifs on curved and narrow bronze surfaces. So they used foreshortening to construct dynamic scenes, evolving from the symmetrical patterns of the taotie, a beast in Chinese mythology symbolizing gluttony.

In the 20th century, the Western scholar Michael Sullivan introduced the *Cuo Jin Yin* technique to the Western world. In 2014, the gold and silver inlay craftsmanship was inscribed in China's national intangible cultural heritage list.


A bronze chariot axle cap inlaid with gold and silver is displayed at an exhibition in Beijing on February 26, 2026. (PHOTO: VCG)