

Architect of Quantum Mathematics

Dialogue

By LONG Yun & BI Weizi

There is a certain old-fashioned elegance in the way Professor Nicolai Reshetikhin teaches. In an age dominated by digital presentations and slide decks, this world-renowned mathematical physicist chooses to write everything on the blackboard, line by line, with meticulous precision.

In 2021, shortly after joining Tsinghua University's Yau Mathematical Sciences Center (YMSC), his handwritten lecture notes went viral on Chinese social media platforms for their clarity, rigor and aesthetic beauty.

Reshetikhin is one of the founding figures of quantum group theory, a pioneer behind the Reshetikhin-Turaev (RT) invariants, a major contributor to quantum integrable systems, and a key figure in advancing our understanding of Poisson geometry and Quantum Kac-Moody algebra. His work bridges abstract mathematical structures with deep physical insights, making him one of the most influential thinkers in modern mathematical physics.

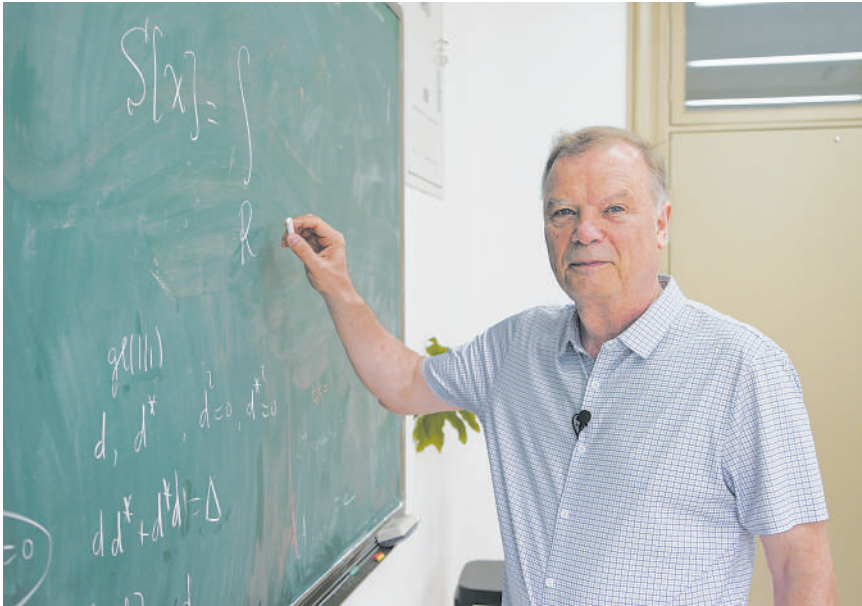
From nuclear engineering to mathematics

When asked how he chose mathematics as his life's work, Reshetikhin explained, "I didn't start as a mathematician. I was in the engineering school, studying nuclear engineering for three years."

This early exposure to applied sciences later shaped his approach to theoretical problems. After shifting to theoretical physics at university, he found his calling in mathematics during an internship at a prestigious mathematical institute. That transition from practical nuclear engineering to the abstract world of quantum symmetries set the stage for a career marked by groundbreaking discoveries.

Quantum groups: hidden symmetries of the universe

One of the most abstract yet funda-



Professor Nicolai Reshetikhin. (PHOTO: Science and Technology Daily)

mental aspects of Reshetikhin's work lies in quantum groups. When asked to explain them simply, he offered an intuitive analogy: "Quantum groups generalize the notion of symmetry. Just as classical symmetry groups describe rotations in space or reflections in crystals, quantum groups describe more complex, hidden symmetries."

These symmetries are not visible in the traditional geometric sense but emerge in quantum mechanical systems. They form the backbone of modern developments in mathematics and theoretical physics. For example, quantum groups underlie the structure of knot invariants, allowing mathematicians to distinguish different knots using algebraic tools. This led directly to the Reshetikhin-Turaev invariants, now a cornerstone of low-dimensional topology.

But their importance extends beyond pure mathematics. Quantum groups appear in conformal field theory, topological quantum computing, and statistical mechanics. Their rich algebraic structure continues to inspire new research across disciplines.

Quantum integrability and the mystery of entanglement

Another major theme in Reshetikhin's work is quantum integrable systems.

These rare systems, with a high degree of internal symmetry, often allow exact solutions, illuminating deeper physical principles.

He elaborated: "In many quantum integrable systems, quantum groups describe the hidden symmetries." When asked about the relationship between integrability and quantum entanglement, a topic of growing interest due to quantum computing, Reshetikhin noted that while entanglement is not directly tied to integrability, these systems provide ideal laboratories for studying it.

He highlighted the work of physicists like John Cardy and Vladimir Korepin among many others, who explored entanglement in integrable settings. He also noted China's growing role in this research, where scientists are advancing quantum information and integrability.

The future of mathematical physics

Looking ahead, Reshetikhin identified key open questions in mathematical physics. One is the rigorous formulation of quantum Yang-Mills theory, a Millennium Prize Problem.

"For example, one of the famous Millennium Problems aims to establish a rigorous mathematical foundation for

the quantum field theory underlying the Standard Model — specifically, Yang-Mills theory — and more generally, non-Abelian gauge theories."

He called the problem both formidable and fascinating. "Physicists use approximations, but a mathematically consistent theory is still absent."

Most ambitiously, he acknowledged the struggle to reconcile gravity with quantum field theory.

"There are many interesting questions about gravity, like how to fit it with quantum field theory, whether it should remain classical, or whether quantum gravity exists. This debate is not over." He added, "Mathematically speaking, there is close to zero progress in understanding quantum gravity."

Serving as a bridge

Despite his focus on abstract theories, Reshetikhin sees science as a human endeavor transcending borders. His footsteps have touched many countries to promote global scientific development. "International cooperation is very important. The more exchanges, collaborations, and visits, the better."

Reshetikhin embraces his dual role as a scientist and mentor. "I'm driven by my internal interest in research. I'm very lucky to be actively involved in my career."

To young researchers who choose between theory and application, he advised: "Follow your curiosity. Fundamental research may seem distant from real-world impact, but history shows the most important breakthroughs come from exploring the unknown."

At the end of the interview, Reshetikhin handed us his handwritten notes to ensure the article's precision and clarity. This small act reflected his traits as a respectable scientist with rigorous dedication and a commitment to advancing public understanding. Reshetikhin bridges disciplines and cultures, proving that science thrives on both brilliance and the willingness to illuminate the path for others.

NIU Yun from YMSC also contributed to this article.

the purity of the Hanshui River and the spirit of innovation with people everywhere.

Meanwhile, the visiting group of 19 foreign experts and scholars specializing in environmental science, information technology, vehicle engineering, and cultural heritage protection carried out in-depth discussions with local universities, enterprises, water conservation centers and scientific research institutions. The discussions focused on water conservation and protection, industrial development, and the protection of world cultural heritage.

China Impression

Global South Lauds China's Efforts in Peaceful Nuclear Use

By WANG Zhenghong, LONG Yun & BI Weizi

China's leading role in peaceful nuclear applications and its cutting-edge nuclear infrastructure and research advancements were highlighted at the China Nuclear Industry Explorer (CNIE), a high-level diplomatic and technological exchange held in Shandong province and Beijing from June 22 to 27.

Co-organized by the China Atomic Energy Authority (CAEA) and the Permanent Mission of China to the United Nations and Other International Organizations in Vienna, the event was attended by senior diplomats from Ghana, Brazil, Namibia, Bangladesh, Nigeria, Pakistan, Venezuela, and Indonesia.

They also participated in the "Atom for a Better Home" roundtable on cooperation in peaceful use of nuclear technology. Officials from CAEA briefed them on China's efforts to promote safe, sustainable nuclear energy development and apply nuclear technologies to improve people's livelihoods. China's people-centered development philosophy was emphasized, demonstrating how nuclear science and technology is being applied across industries such as agriculture, medicine, environmental protection to drive high-quality economic and social development.

Claudia Vieira Santos, the designation of Ambassador Claudia Vieira Santos as Permanent Representative of Brazil to the International Atomic Energy Agency (IAEA) in Vienna, commended China's peaceful use of nuclear technology, saying it has made substantial contributions to developmental applications, such as agricultural research ('Atoms for Food'), power generation for climate change mitigation, and replacing fossil fuels.

"Additionally, the scale of China's power applications has spurred innovation, including advanced reactor models and materials, expanding options for developing countries," she added.

Toufique Hasan, Bangladesh's permanent representative to the United Nations (Vienna), echoed this sentiment. "We see China as a key collaborator," he said, expressing interest in deeper collaboration with China on education, training, and capacity building.

Matilda Aku Alomatu Osei-Agye-

man, Ghana's permanent representative to the United Nations (Vienna), told *Science and Technology Daily*, "China is very advanced in nuclear technology. We could send our people to be trained there and share equipment. In the developing world, we lack resources. Learning from China's best practices is a practical way forward."

She anticipated China-Africa or China-Ghana collaboration would lead to more facilities and more people-to-people exchanges. "It's not just about the machines; it's also about training people to diagnose and treat diseases properly," she added.

All participating officials recognized China's achievements in nuclear science and technology and its significant contributions to advancing nuclear energy programs in the Global South.

The delegation also visited the Huaneng Shidao Bay High-Temperature Gas-Cooled Reactor Demonstration Project in Shandong province, Shandong Nuclear Power Equipment Manufacturing Co., a subsidiary of State Power Investment Corporation, National Nuclear Security Technology Center, China Institute of Atomic Energy, Chinese Academy of Agricultural Sciences, the Tongfang Weishi Industry-Academia Research Base, and China Nuclear Power Engineering Co.

The CNIE is a key step in China's ongoing efforts to enhance international exchange and cooperation in the nuclear field. It serves as a bridge for increasing understanding of China's nuclear industry and expanding bilateral and multilateral collaboration on peaceful uses of nuclear technology.

Since joining the IAEA in 1984, China has consistently stood by the rest of the Global South, safeguarding their legitimate rights to peacefully use nuclear energy and jointly promoting the application of nuclear science and technology for sustainable development.

With the vision of building a community with a shared future for humankind, the CAEA reaffirmed its commitment to deepening partnerships with the IAEA and Global South nations to promote nuclear innovation, foster inclusive global nuclear development, and expand cooperation in the nuclear industry, science and technology, and talent development.



The delegation visit the Huaneng Shidao Bay High-Temperature Gas-Cooled Reactor Demonstration Project in Shandong province. (PHOTO: CAEA)

Large-scale Facilities Boost Research on Cultural Relics

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Without causing any damage to the cultural relics, neutron imaging can clearly demonstrate their inner structure and details.

In cooperation with the Palace Museum, Wei's team researched an iron knife with a painted sheath, used to correct mistakes on bamboo slips from the Western Han Dynasty (202 BC- 8 AD) with the help of CSNS.

The reconstruction of slice images by neutron CT scans revealed the

main components of the rust inside the knife and its 3D distribution, and displayed craft details like the composite structure of the cutting edge, offering a new perspective for research on the rusting process of cultural relics.

More specific equipment for the research of cultural relics is also emerging. "I believe, with the help of high tech, we can better preserve and pass down the invaluable cultural heritage of humankind," Wei said.

Foreign Experts Explore Shiyan's Charm

Expats Activity

By Staff Reporters

Recently, a China Tour event for foreign experts and scholars, organized by the Beijing Overseas Talents Center and Shiyan Municipal Government, took place in Shiyan, Hubei province. Presenting the city's three world-

class attractions, Huang Jianxiong, secretary of the Shiyan Municipal Party Committee, listed Fairy Mountain, Beautiful Water and Auto City.

"The ancient buildings on Wudang Mountain reflect the philosophical idea that Tao follows nature, and heaven and man are one. The Danjiangkou Reservoir provides water for 120 million people in northern China, and Shiyan is referred to as Auto City, since it produces over 100 vehicles

types and 4,000 vehicle parts," said Huang.

At the event, Francesco Faiola of the Research Center for Eco-Environmental Sciences at the Chinese Academy of Sciences, said that although he had some prior knowledge of the Shiyan, he was still amazed by its rapid development and remarkable achievements. He hopes to act as a bridge between Shiyan and the rest of the world, sharing the wisdom of Wudang,

Regong Arts Blend History, Culture

Traditional Eastern Wisdom

By BI Weizi

Regong arts, primarily recognized for their thangka paintings, are a significant and unique aspect of Tibetan Buddhist culture. In 2009, they were added to UNESCO's Representative List of the Intangible Cultural Heritage of Humanity.

Regong translates to "golden valley where dreams come true" in Tibetan language. This "valley" is situated in the middle reaches of the Longwu River in Tongren, Qinghai province. In the 13th century, Regong arts emerged from this "valley" and evolved into a well-known tradition of Tibetan Buddhist art. As a collection of diverse artistic

forms, Regong arts mainly include thangka painting, sculpture, embroidery, and architectural embellishment. Monks, folk artists, as well as local farmers, herdsmen, and craftsmen from diverse ethnic groups have played a role in nurturing this cultural heritage.

As one of the most widely recognized forms of Regong arts, thangka paintings have gained fame around the world. Renowned for their intricate craftsmanship, vibrant colours, and deep symbolism, thangkas are primarily made to honor the Buddha, legendary deities, and distinguished monks. These artworks vary greatly in size, with the large pieces regarded as extremely valuable and sought after by temples, museums, and collectors.

Another distinct feature of thangka paintings is their exquisite colours, predominantly sourced from natural

minerals that can protect the vibrancy of artworks from fading for several centuries. Regong artists grind various minerals and metals including gold, silver, turquoise, malachite, saffron, and indigo to produce vibrant pigments. Additionally, the artists rigorously adhere to the *Lection of Measurement*, a Buddhist art book, to create lines, form shapes, select colors, design patterns, and produce decorative effects.

"The important historical cultural heritage reflects the essence

of the culture of Tibetan Buddhism monasteries and folk arts in Regong areas, having remarkable social, historical and artistic values," according to UNESCO.



A thangka painting on display in Chifeng, north China's Inner Mongolia autonomous region. (PHOTO: VCG)