China’s quantum satellite achieves ‘spooky action’ at record distance

A team of Chinese scientists have realized the satellite-based distribution of entangled photon pairs over 1,200 kilometers. The photon pairs were demonstrated to be still entangled after travelling long distances.

The experiment shows quantum entanglement, described by Albert Einstein as a “spooky action”, still exists at such a distance.

This satellite-based technology opens up bright prospects for both practical quantum communications and fundamental quantum optics experiments at distances previously inaccessible on the ground, said Pan Jianwei, an academician of the Chinese Academy of Sciences.

The achievement was made with the world’s first quantum satellite, Quantum Experiments at Space Scale (QUESS); also dubbed Micius, launched by China on August 16, 2016, and was published as a cover article in the latest issue of academic journal Science.

This experiment was made through two satellite-to-ground downlinks with a total length varying from 1,600 to 2,400 kilometers. The obtained link efficiency is many times higher than that of the direct bidirectional transmission of the two photons through telecommunication fibers, said Pan, who is also the lead scientist of QUESS.

Quantum entanglement is a phenomenon in quantum physics, which is so confounding that Albert Einstein described it as a “spooky action at a distance” in 1948.

Scientists found that when two entangled particles are separated, one particle can somehow affect the action of the far-off twin instantly.

Scientists liken it to two pieces of paper that are distant from each other: if you write on one, the other immediately shows your writing.

The mystery of quantum entanglement has been puzzling scientists since it was detected.

Quantum physicists have a fundamental interest in distributing entangled particles over increasingly long distances and studying the behavior of entanglement under extreme conditions.

In theory, this bizarre connection can exist over any distance, but scientists want to see if there’s some physical limit. “If you want to explore new physics, you must push the limits,” Pan said.

“Will gravity affect quantum entanglement? It needs long-distance experiment to test the different models. Although QUESS cannot test quantum gravity theories yet, we have developed the technologies needed for space-based

experiments through this project," Pan said.

Previously, entanglement distribution had only been achieved at a distance up to 100 kilometers due to photon loss in optical fibers or terrestrial free space.

One way to improve the distribution lies in the protocol of quantum repeaters, whose practical usefulness, however, is hindered by the challenges of quantum storage and readout efficiency, Pan said.

Another approach is making use of satellite-based and space-based technologies, as a satellite can conveniently cover two distant locations on Earth. The main advantage of this approach is that most of the photons' transmission path is almost in a vacuum, with almost zero absorption and de-coherence, Pan said.

After feasibility studies, Chinese scientists developed and launched QUESS for the mission of entanglement distribution. Cooperating with QUESS are three ground stations: Delingha Observatory in Qinghai, Nanshan Observatory in Xinjiang and Gaomeigu Observatory in Yunnan.

For instance, one photon of an entangled pair was beamed to Delingha and the other to Gaomeigu. The distance between the two ground stations is 1,203 kilometers. The distance between the orbiting satellite and the ground stations varies from 500 to 2,000 kilometers, said Pan.

Due to the fact that the entangled photons cannot be amplified as classical signals, new methods must be developed to reduce the link attenuation in the satellite-to-ground entanglement distribution. To optimize the link efficiency, Chinese scientists combined a narrow beam divergence with a high-bandwidth and a high-precision acquiring, pointing, and tracking (APT) technique.

An accurate transmission of photons between the "server" and the "receiver" is never easy, as the optic axis of the satellite must point precisely toward those of the telescopes in the ground stations, said Zhu Zhencai, QUESS chief designer.

What makes it much harder is that the satellite flying over the Earth at a speed of 8 kilometers per second can be continuously tracked by the ground station for just a few minutes.

"It is like tossing a coin from a plane at 100,000 meters above sea level exactly into the slot of a rotating piggy bank," said Wang Jianyu, QUESS project's chief commander.

The highly sensitive QUESS could make visible from the Earth a match being lit on the Moon, Wang added.

By developing an ultra-bright space-borne two-photon entanglement source and the high-precision APT technology, the team established entanglement between two single photons separated by 1,203 kilometers.

Compared with the previous methods of entanglement distribution by direct transmission of the same two-photon source – using the best performance and most common commercial telecommunication fibers respectively – the effective link efficiency of the satellite-based approach is 12 and 17 orders of magnitude higher, Pan said.

He said the distributed entangled photons are readily useful for entanglement-based quantum key distribution, which, so far, is the only way to establish secure keys between two distant locations on Earth without relying on trustworthy relay.

“So far, this is the most important scientific research progress in my life,” said Pan, who has been engaged in the quantum physics for more than 20 years and has been granted the highest natural science award for his achievement in quantum science.

“For the first time, we’re testing the physical law of the micro world on a space scale, and laying the foundation for exploring more basic laws in physics in the future. The technologies can also be applied in constructing a quantum network,” Pan said.

The reviewers of Science magazine said of the team’s article that it is a major technical accomplishment with potential practical applications as well as being of fundamental scientific importance.

QUESS is also designed to establish “hack-proof” quantum communications by transmitting uncrackable keys from space to the ground, as well as testing quantum teleportation with a ground station in Ali, Tibet.

According to Pan, scientists also plan to test quantum key distribution between ground stations in China and in Austria, and establish encrypted video calls between Beijing and Vienna. Countries like Canada also expressed a willingness to cooperate with China in future quantum satellite experiments.

Currently, QUESS can only send photons at night. Chinese scientists hope to develop technologies to realize around-the-clock work. They also hope to launch a quantum satellite to a higher orbit to make more practical use possible, according to Wang.

Pan revealed they also want to see if it’s possible to distribute entanglement between the Earth and the Moon at a distance of some 300,000 kilometers in future to test relevant physical theories.

China, ADB establish green financing

platform to curb air pollution

A green financing platform jointly supported by China and the Asian Development Bank (ADB) was launched Friday to help fight air pollution in the Beijing-Tianjin-Hebei region and its neighboring areas.

The platform, launched by the China National Investment and Guaranty Corporation (I&G), the State Development and Investment Corporation and the ADB, is expected to leverage more than 27 billion yuan (3.96 billion U.S. dollars) of investment to support pollution control in the region.

Lending from the platform will go to support energy structure improvement in the Beijing-Tianjin-Hebei region, as well as control and prevention of mobile source pollution, industrial pollution and nonpoint source pollution.

The ADB has approved a loan of 458 million euros (511.24 million dollars) to support the platform, according to the bank.

The ADB said the platform will help small- and medium-sized enterprises, who lack the experience to tackle pollution and financing source to switch to cleaner processes, to have easier access to loans from commercial banks.

The I&G said it expects the platform to help save about 40.2 million tonnes of standard coal, cut carbon dioxide emissions by 8.55 million tonnes and sulphur dioxide emission by 510,000 tonnes in the Beijing-Tianjin-Hebei region.

China is planning more ways to encourage green financing, which is gaining steam but still in the early stage.

The State Council, China’s Cabinet, Wednesday announced its decision to set up pilot zones in Guangdong, Guizhou, Jiangxi and Zhejiang provinces and Xinjiang Uygur Autonomous Region to boost green finance development.

China court sentences 7 over falsifying air quality data

A Chinese court Friday sentenced seven people, including the heads of two environmental protection branches, to imprisonments of over one year for falsifying air quality monitoring data.

Xi’an Intermediate People’s Court in northwest China’s Shaanxi Province convicted the two of interfering in data collection of the automated air quality monitoring system and using cotton to fill the sampling instrument to

lower the pollution data, in February and March 2016.

He Limin, then head of Chang'an District Branch of Xi'an Environmental Protection Bureau, and Tang Shixing, then head of Yanliang District Branch under the bureau, ordered staff from national monitoring stations in the two districts to falsify the data, said the court.

The court found them guilty of damaging the computer information system. The court sentenced He to one year and seven months and Tang to one year and five months.

Li Sen and Zhang Feng, then heads of the Chang'an and Yanliang monitoring stations respectively, were given imprisonments of one year and ten months, and one year and seven months, respectively. Three others were also sentenced.

HSL: RPE Fit Test-Introduction – Buxton, 20 July 2017

Book Course

HSL is to run a 1 day course on RPE Fit Test – Introduction.

20 July 2017

Introduction

Tight-fitting Respiratory Protective Equipment (RPE) needs to fit the wearer's face well in order to work correctly and provide the expected protection. As faces come in all shapes and sizes, each wearer needs to be supplied with a facepiece which matches their face. Fit testing demonstrates how well a facepiece matches the individual's face; it is used to select a facemask which is a good match for them. HSE's relevant Approved Codes Of Practice (ACOP) require that fit testing be carried out as part of the initial RPE selection process, to ensure that the wearer has the correct facepiece.

This course will explain the importance of fit testing, the responsibilities of employers and introduce the various fit testing methods. Practical sessions will cover the essential skills of pre-use checking and correct donning of facepieces, before going on to provide opportunity to practice fit testing using the 2 methods which are extensively and almost exclusively in use in the UK. It is therefore ideal for those new to, or relatively new to, practical fit testing and also suitable for those with responsiblility for correct selection of respiratory protection.

This is in an introductory course which will provide a good foundation on which to build practical fit testing skills. To become a competent fit tester will require considerable additional practice and experience. Our **Respiratory Protective Equipment (RPE) fit testing – Advanced** course is suitable for those who are well on the way to becoming competent fit testers and are possibly considering applying for accreditation under the Fit2Fit scheme.

All course presenters are Fit2Fit accredited fit testers, some were actively involved in the development of the Fit2Fit scheme.

This Introduction Course includes:

- Understanding the importance of fit testing
- Principles of fit testing methods
- Essential pre-use checking and correct donning of facemasks
- Responsibilities of employers and fit testers
- Qualitative fit testing using Bitrex or Saccharin
- Quantitative fit testing using the Portacount

Who should attend:

Individuals who are new to or relatively new to practical fit testing and those with responsibility for correct selection of respiratory protection.

More information on the Fit2Fit scheme is available at http://fit2fit.org/index.html

Venue

The course will be run at the HSL laboratory in the spa town of Buxton. Buxton is in the heart of the Peak District and has good links to mainline train stations and Manchester International Airport.

Details of hotels in the Buxton area can be found at www.visitpeakdistrict.com.

Cost

The discounted cost of this course is £600 per person (includes course notes, lunch and refreshments).

Comments & Feedback
"The team/trainers were fantastic and brimmed with knowledge, not just the technical elements, but down to earth 'working' solutions that can be applied in the workplace. In one word fantastic. I would thoroughly recommend HSL, a

great organisation! Please keep providing training, there is no service/training provider like the HSL."
Richard Browne (CARE UK)

Book Course

Please note the invoice option is not available within 4 weeks of the course date, or for overseas customers. If you are selecting the invoice option for payment, it will be mandatory to input a purchase order/reference number as we are unable to process booking forms without this.

For further dates and additional information email: training@hsl.gsi.gov.uk or contact the Training & Conferences Unit at HSL directly on +44 (0)1298 218806.

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HSL: RPE Essentials – Buxton, 18-19 July 2017

Book Course

HSL is to run a 2 day course on RPE Essentials.

18-19 July 2017

Introduction

Whilst the use of RPE should only be considered when other control measures are impractical or after their implementation a residual risk remains, there are many workplace situations where RPE is required.

RPE is capable of providing effective protection, provided that it is correctly selected, used and maintained. Unsuitable, poorly maintained and incorrectly used RPE may give limited protection, or may not provide any protection. This could lead to ill heath in the short or long term, with the possibility of permanent disability. If the RPE is being used in conditions where there is an immediate danger to life and health, the situation could prove fatal.

This course will increase your knowledge and understanding of RPE and how it can be used effectively in the workplace as a control measure. It will provide training in correctly selecting adequate and suitable RPE (following the principles of HSG 53 and COSHH essentials), and how it should be used and maintained. The course will include practical elements to enhance learning and provide practical skills.

What will the course cover?

Who should attend?

Persons with responsibility for RPE selection, use and maintenance in a workplace. Those who users may rely upon for guidance on what equipment to obtain and use e.g. suppliers.

Venue

The course will be run at the HSL laboratory in the spa town of Buxton. Buxton is in the heart of the Peak District and has good links to mainline train stations and Manchester International Airport.

Details of hotels in the Buxton area can be found at www.visitbuxton.co.uk

Cost

The cost of this course is £1100 per person (includes course notes, lunch and refreshments).

Book Course

Please note the invoice option is not available within 4 weeks of the course date, or for overseas customers. If you are selecting the invoice option for payment, it will be mandatory to input a purchase order/reference number as we are unable to process booking forms without this.

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