Secure information transmission over 500m fiber links based on quantum technologies

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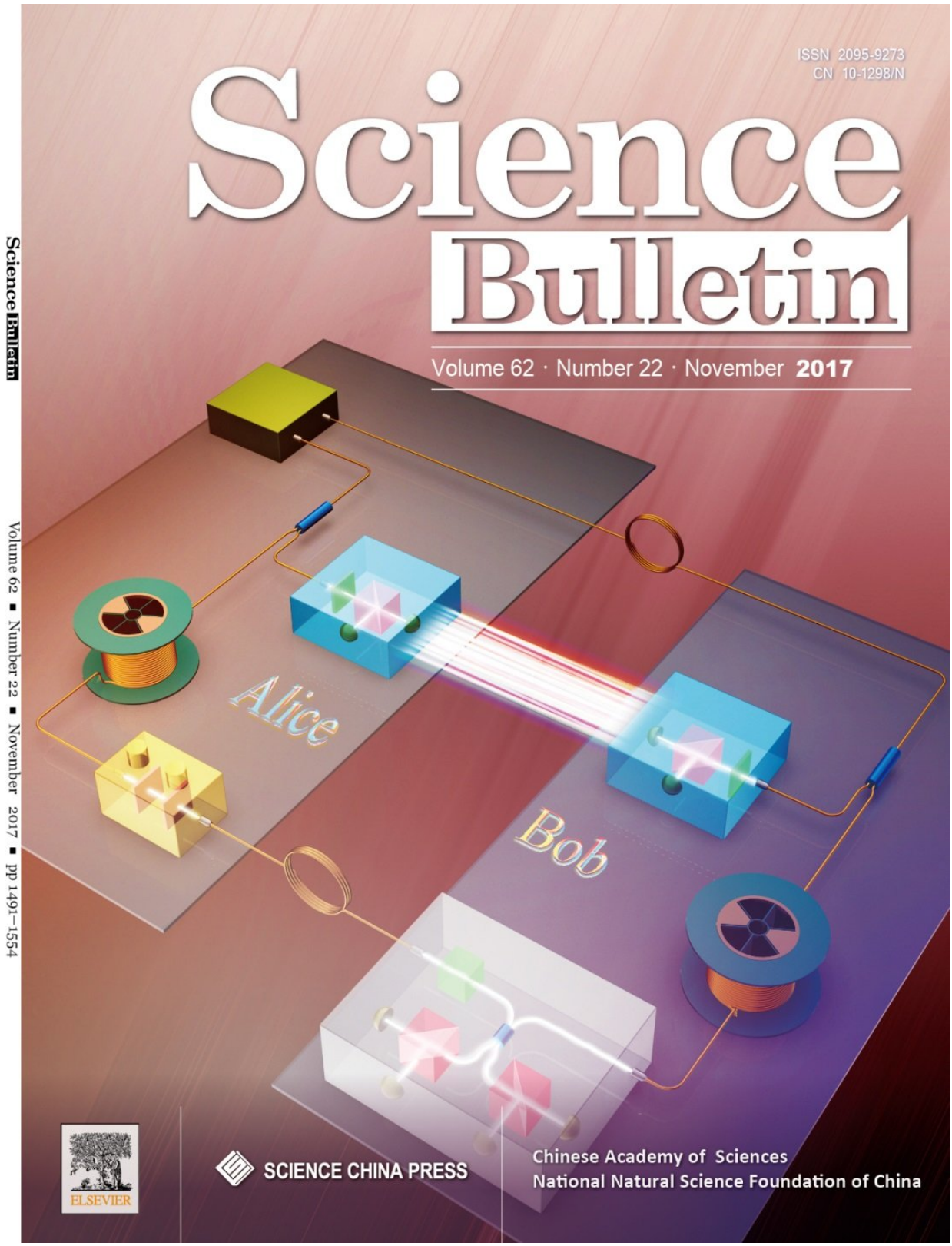

Experimental system of quantum secure direct communication over optical

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Quantum secret communication realizes secure information transmission-based on quantum principles. At present, the most developed quantum secret communication schemes are-based on quantum key distribution. In these schemes, the quantum function is limited to realize secret key generation and transmission, while the information transmission still depends on classical communication technologies.

Such schemes are now mature enough for commercial applications. On the other hand, researchers in the field of quantum communications still devote their efforts into exploring novel communication schemes-based on quantum information theories and technologies, which are beyond quantum key distribution.

A representative topic is quantum secure direct communication (QSDC). The first QSDC protocol is-based on quantum entanglement was proposed in 2000 by Prof. Long in Tsinghua University, China. It has been deeply investigated theoretically, but there has been no breakthrough in experiments for this protocol. The reason is that it requires many complicated quantum functions such as entangled Bell state generation, Bell state measurement and quantum memories for photons, which are difficult to realize.

Recently, Prof. Zhang's group in Tsinghua University realized the first entanglement-based QSDC experiment-based on technologies of fiber optics, in which two optical fibers of 500 meters are used as quantum channels. Firstly, according to the requirement of entanglement-based QSDC, they proposed and developed a novel fiber-based quantum light source for polarization entangled Bell state generation at telecom band.

The key question of this quantum light source is how to split the two photons in a pair, which are both polarization entangled and frequency degenerate. The researchers introduce vector-spontaneous, four-wave mixing effects into a fiber Sagnac loop bi-directionally, splitting the two photons in a pair by the two-photon interference effect at the output ports of the fiber Sagnac loop. This quantum light source paves the way to realize the entanglement-based QSDC over optical fibers. Then, the researchers established the experimental system for entanglement-based QSDC-based on technologies of fiber optics, realizing the polarization entangled Bell state measurement system by fiber components and using dispersion shifted fibers as the quantum memories for photons. In this system, they demonstrated two crucial functions of entanglement-based QSDC successfully, security testing by the measurement of polarization entanglement and encoding/decoding processes based on the manipulation and measurement of the polarization entangled Bell states. Experimental results showed that the entanglement-based QSDC could be realized over fiber links.

This work is the first entanglement-based QSDC experiment with full functions, using optical fibers of 500 meters as the quantum channels and realizing all the functions based on technologies of fiber optics, including polarization entangled Bell state generation and measurement, and the quantum memories. It shows that QSDC can be realized by on-shelf technologies of optical communications, which is preferred for its future applications in optical fiber networks.

More information: Feng Zhu et al, Experimental long-distance quantum secure direct communication, *Science Bulletin* (2017). DOI: 10.1016/j.scib.2017.10.023

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