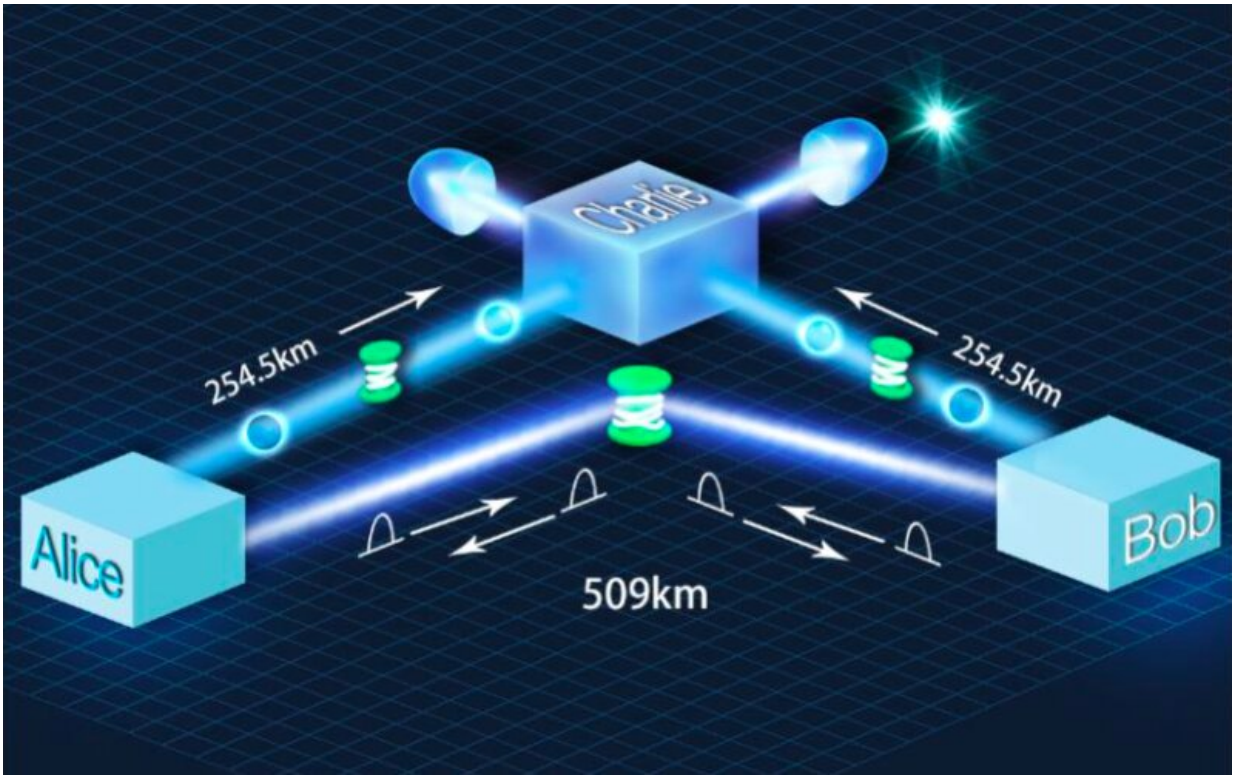
Study achieves a new record fiber QKD transmission distance of over 509 km

March 9 2020, by Ingrid Fadelli



Credit: Chen et al.

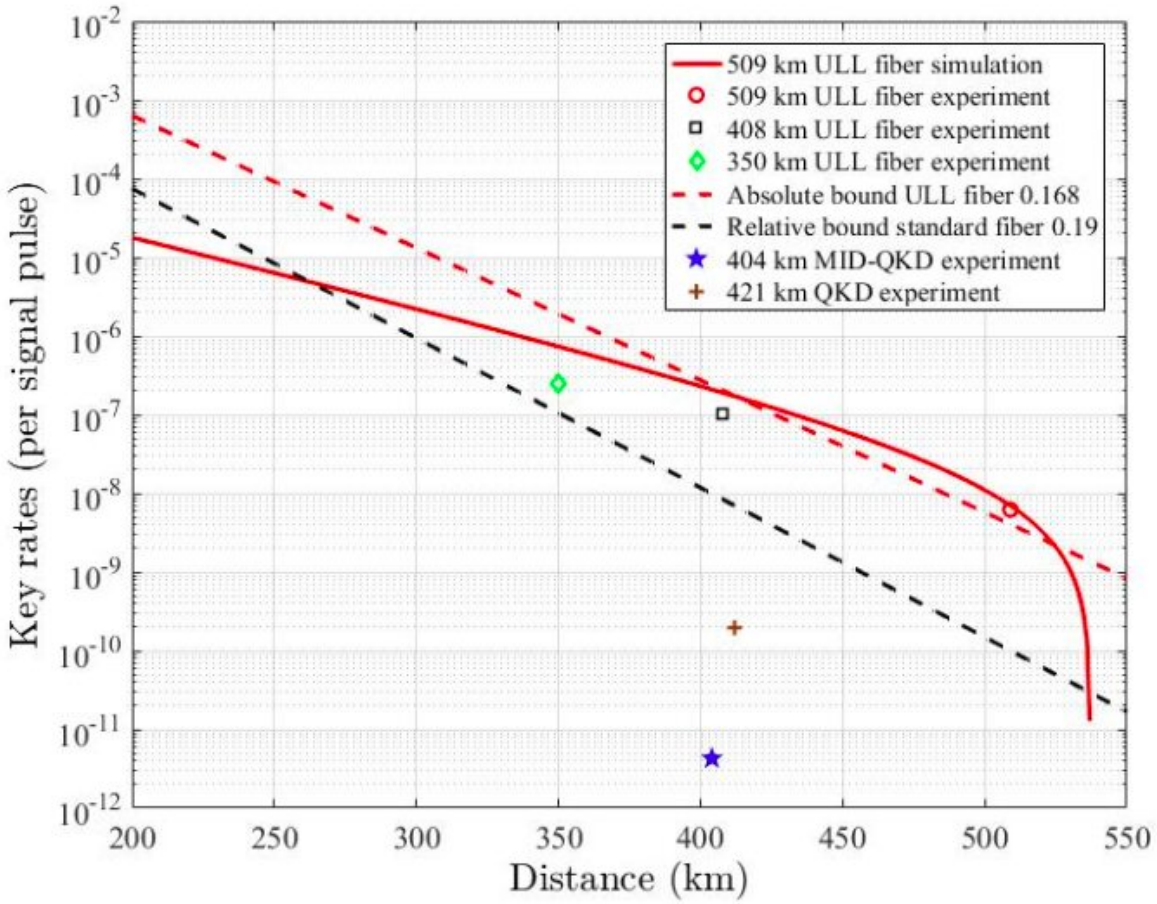
The sending-or-not-sending twin-field (SNS-TF) protocol has so far proved to be a highly promising strategy for achieving high rates over long distances in quantum key distribution (QKD) applications. In fact, by tolerating large misalignment errors, this protocol can surpass the

repeaterless bound in more effective ways, which is a crucial factor in the realization of long-distance QKD.

Jian-Wei Pan, Qiang Zhang, Xiang-Bin Wang and other researchers at the University of Science and Technology of China and Tsinghua University have recently achieved an unprecedented QKD transmission distance using the SNS-TF protocol. Their paper, published in *Physical Review Letters*, reports QKD with a secure key distribution breaking the repeaterless bound over a 509-km-long optical fiber.

"Using the sending-or-not-sending twin-field (SNS-TF) protocol, we realized secure quantum key distribution (QKD) over 509 km, which is a new record secure distance in QKD over fiber," Qiang Zhang, one of the researchers who carried out the study, told Phys.org. "One of the important objectives of our study was to successfully break the absolute key-rate limit of repeater-less QKD, with any measurement device."

The SNS-TF protocol was developed and introduced in a previous research effort by some of the researchers who wrote the recent paper. In previous studies, the protocol proved to be highly advantageous for QKD applications, particularly for achieving long distance transmission.



Credit: Chen et al.

In their recent work, Zhang and his colleagues implemented the SNS-TF QKD protocol by eliciting a single-photon level, first-order interference between two independent lasers. These two independent lasers were combined with a remote frequency locking technique, ultimately enabling QKD transmission over unparalleled distances. In their experiments, the researchers also used superconducting single-photon detectors with high count rate and detection efficiencies.

"We adopted technology typically employed in time-frequency

dissemination research and locked two independent lasers' frequency in an ultra-narrow laser cavity," Zhang said. "Then, we time-multiplexed strong laser light as phase reference with the quantum signal in one fiber. The strong light induced lots of noise counts, but we exploited many filtering methods to avoid this."

Using their SNS-TF approach, the researchers achieved a secure key rate at 509 km, over seven times higher than the relative repeaterless bound QKD, and with the same detection loss. Remarkably, the key rate they achieved is also higher than that achieved by more traditional QKD protocols running on a perfect repeaterless QKD device.

"We experimentally provided a new record for fiber QKD transmission distance and demonstrated that it breaks the absolute key-rate limit of repeaterless QKD," Zhang said. "In our future research, we plan to explore higher key rate and longer distance."

In their recent study, the researchers gathered new evidence confirming the potential of the SNS-TF QKD protocol and showed how this scheme can be combined with technological tools to achieve high secure key rates across long distribution distances. Their work could soon enable the large-scale implementation of QKD with relatively high key rates at 200-300 km, which could be particularly useful for the development of intra-city QKD networks. In fact, applying their technology to QKD main trunk lines could help to reduce trustful relays, resulting in more efficient QKD.

More information: Jiu-Peng Chen et al. Sending-or-Not-Sending with Independent Lasers: Secure Twin-Field Quantum Key Distribution over 509 km, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.124.070501

Xiang-Bin Wang et al. Twin-field quantum key distribution with large

misalignment error, *Physical Review A* (2018). DOI: 10.1103/PhysRevA.98.062323