Accurate Time Synchronization for Satellite-to-Ground Quantum Key Distribution

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Abstract

Quantum key distribution (QKD) can ensure a information-theoretical-secure key between communication parties. Relayed by quantum satellites, a intercontinental quantum secure communication network can be constructed to provide ITS protection for critical applications. Here, we report a novel high accurate time synchronization (HATS) scheme for satellite-to-ground QKD systems. Based on the frequency spread feature of synchronization laser, the HATS scheme can automatically adapting the relative delay between the quantum satellite and ground stations. The HATS scheme is implemented with a 10 kHz beacon laser in QKD between “Micius” and Graz ground station, which ensures a 1.1 ns coincidence window and the established secure key rate is around 1 kbps.

Quantum key Distribution (QKD), based on quantum fundamental principles, can generate information-theoretical-secure (ITS) keys for communication parties. In 2016, the Low-earth orbit quantum satellite (“Micius”) was successfully launched in China and the satellite-to-ground QKD was performed between “Micius” and optical ground stations [1, 2, 3]. Relayed by quantum satellites, a intercontinental quantum secure communication network can be constructed to provide ITS protection for critical applications. In satellite-to-ground QKD systems with low repetition frequency, time synchronization can be implemented with pulse-per-second (PPS) signals assisted by the global position system (GPS) [4]. For high speed satellite-to-ground QKD systems, Doppler shift during accurate time synchronization is difficult to be compensated only with PPS signals.

Based on the frequency spread feature of synchronization laser, we propose a novel high accurate time synchronization (HATS) scheme for satellite-to-ground QKD systems, which can automatically adapting the relative delays. With a 10kHz beacon laser, we implemented our HATS scheme in the decoy-state QKD between “Micius” and Graz ground station, which ensures a 1.1 ns coincidence window and the established secure key rate is around 1 kbps. With these secure keys, a “quantum safe” video conference was performed between the Austrian Academy of Sciences and the Chinese Academy of Sciences [1].


