Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **3367** Type: **Poster Competition (Graduate Student) / Compétition affiches (Étudiant(e) 2e ou 3e cycle)**

(G*) (POS-4) Wavelength-multiplexed entanglement-based quantum key distribution

Tuesday 7 June 2022 17:36 (2 minutes)

Quantum Key Distribution (QKD) has reached a level of maturity sufficient for commercial implementation. However, to-date transmission distances remain curtailed due to absorption losses. Satellite links have been proposed as a solution to scale up the distances of quantum communication networks. By using orbiting satellites as nodes between ground stations, the signal-to-noise ratio is improved as most of the photons' propagation path is in empty space. Yet such satellite based quantum links currently suffer from low photon count rates, due to the atmospheric effects and the limitations of current entangled photon sources. Furthermore, while a practical quantum network necessitates connectability to multiple users, most QKD implementations so far are limited to two communicating parties. To address this issue, we investigate the use of a wavelength-multiplexing entangled photon source. In this work, we simulate the performance of such a multi-channel operation and show that by using multiple wavelength channels one can improve the secure key rate linearly up to several orders of magnitude whilst maintaining the same quantum bit error rate. Taking advantage of the inherent hyper-correlations produced by the entangled photon source, one can deterministically separate wavelength correlated photon pairs into different detection channels. Hence, every pair of frequency channels can be considered as an independent communication link. In doing so, we can not only circumvent the timing limitation of the photon detectors which leads to an intrisincally increased key rate while maintaining the same signal-to-noise ratio but also enable the interconnectability of a single satellite link with multiple user end-points on the ground. These results indicate the possibility of achieving a very high brightness photon pair generation rate, suitable for satellite-based QKD, without saturation in the detectors. Thus, this method proposes scaling potential to improve quantum communication distances and networkability.

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Session Classification: DAMOPC Poster Session & Student Poster Competition (9) | Session d'affiches DPAMPC et concours d'affiches étudiantes (9)

Track Classification: Technical Sessions / Sessions techniques: Atomic, Molecular and Optical Physics, Canada / Physique atomique, moléculaire et photonique, Canada (DAMOPC-DPAMPC)