

Advances in entanglement distribution from space

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Entanglement distribution is the imperative cornerstone for quantum communication methods such as quantum teleportation, highly secure quantum key distribution, and quantum networks such as the future quantum internet. Satellite-based systems are the ideal choice for providing these services on a global scale because their favourable loss scaling makes them superior to terrestrial solutions with respect to the key obstacle of photon loss.

In this contribution, we will summarize and highlight methods to increase the rate of entanglement distribution and its application such as quantum key distribution (QKD) from space. For this purpose, we will provide an overview of different technical and physical solutions to increase the rate at which entanglement can be distributed [1]. We show that exploiting quantum correlations in different degrees of freedom (DoF) of the photons can be exploited to obtain higher rates as well as better quality of entanglement. In particular, we will showcase three different approaches that utilize these additional quantum correlations.

Firstly, we show how color multiplexing is an easy and technical feasible way to achieve high rates of entanglement [2]; see Fig 1. Secondly, we will demonstrate that different DoF can be used to enhance the quality of entanglement by means of single-copy entanglement distillation [3]. Thirdly, we exploit the hyper-entanglement and high-dimensional entanglement for

increased noise resistance and rates. In this context, we show experimental results over a 10 km free-space link reaching QKD daylight operation [4]. We will conclude with a short outlook.

References

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- [3] S. Ecker, P. Sohr, L. Bulla, M. Huber, M. Bohmann, and R. Ursin, Phys. Rev. Lett. 127 (2021) 040506
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Figures

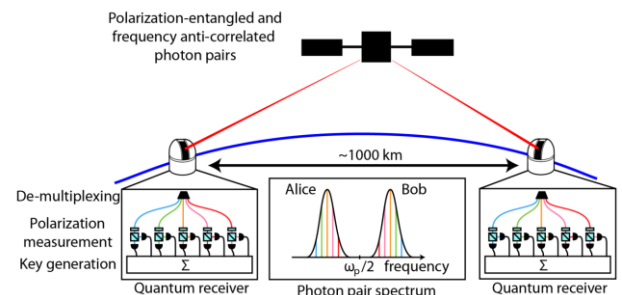


Figure 1: Increased key rates in entanglement-based through color multiplexing [1,2].

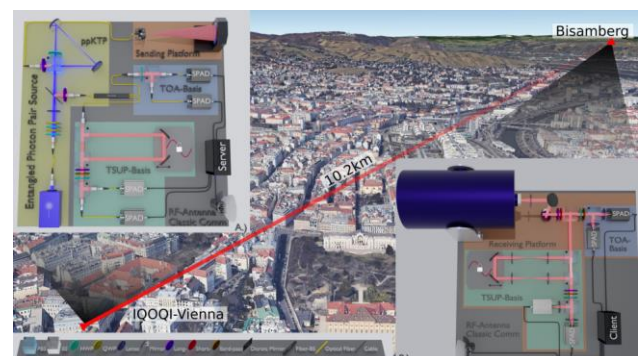


Figure 2: 10 km free-space link realization exploiting hyper- and high-dimensional entanglement [4].