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Quantum cryptography in realistic conditions with structured photons

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Quantum Key Distribution (QKD) is a promising quantum cryptographic solution to maintain information security after the advent of quantum computers. QKD makes use of quantum mechanical properties to construct information-theoretically secure protocols for the transmission of an encryption key between two separated parties, colloquially named Alice and Bob. In the last decade, there have been many efforts across the world to bring QKD schemes and protocols to a technologically feasible level for use beyond the research laboratory, with major advances in free-space and optical fiber channels. A major challenge for these systems when implemented in realistic conditions, e.g. outside laboratories, is the disruptive/degrading effect of environmental factors, such as turbulence or background noise, on the transmitted information. Here, we outline the recent research conducted in Ottawa, Canada, which studies the feasibility of performing QKD in free-space and underwater quantum channels subject to uncontrolled environmental factors. In particular, we study the effect of turbulence on transmitted quantum bit error rates (QBER) in these channels when encoding with the spin and orbital angular momentum degrees of freedom –so-called structured photons –demonstrating the feasibility of high-dimensional QKD schemes. These high-dimensional protocols will enable the transmission of more information, more securely, than conventionally possible.

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