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Quantum photonics for secure quantum computing and novel communication tasks

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Abstract

The precise quantum control of single photons, together with the intrinsic advantage of being mobile make optical quantum system ideally suited for delegated quantum information tasks, reaching from well-established quantum cryptography to quantum clouds and quantum computer networks.

Here I will present that the exploit of quantum photonics allows for a variety of quantum-enhanced data security for quantum and classical computers. First, I will present a homomorphic-encrypted quantum random walk using single-photon states and non-birefringent integrated optics. The client encrypts their input state in the photons' polarization degree of freedom, while the server performs the computation using the path degree of freedom. Then I will briefly discuss the realization of a feasible hybrid classical-quantum technology, which shows promising new applications of readily available quantum photonics technology for secure classical computing by enabling probabilistic one-time programs. As last application for programmable integrated photonics I will present counter-factual communication, where the message is delocalized from the actual physical carrier.