Quantum key distribution and violation of local causality in an urban network using entangled photons generated on demand by a quantum dot

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Abstract

Quantum key distribution is the core feature of secure quantum networks and protocols exploiting entanglement offer additional layers of security which scales favorable with quantum repeaters but are limited to the photon sources. Semiconductor-based quantum emitters are a promising solution in this scenario, ensuring: 1) on-demand generation, 2) near-unity-fidelity entangled photons and 3) record-low multiphoton emission which countering some of the best eavesdropping attacks [1]. In this contribution I will first show the experimental implementation of a free-space link between two different building separated by 270 m within Sapienza university. The photons generated by a coherently driven quantum dot will be actively coupled into single-mode fibers and exploited for an asymmetric Ekert92 QKD protocol [2] where we managed to share a 34.589 kB-long key string and the average values of QBER and Bell parameter are Q=4.0 (2) % and S=2.37(10), respectively [3]. The second part of the presentation will be devoted to the extension of the link previously described to construct a quantum network where two independent sources using different technologies—a quantum dot and a nonlinear crystal—are exploited simultaneously to share a photonic entangled state among three nodes as depicted in Fig.1. We experimentally demonstrate the quantum violation of local causality in a hybrid tripartite quantum network [4], surpassing the classical bound by more than 60 standard deviations and thus prove the emergence of nonclassical correlations that cannot be detected by standard Bell inequalities. Our results pave the way towards the realization of complex networks leveraging the capabilities of hybrid photonic technologies [5].

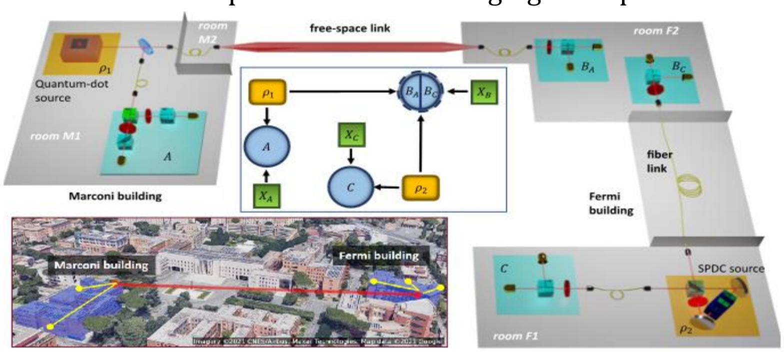

Fig. 1 Experimental implementation of the quantum network. To realize the bilocal scenario, multiple laboratories located in different rooms and buildings were used. In particular, two sources of polarization-entangled photon pairs are realized via a QD device and SPDC in a Sagnac interferometer.

References

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