Mesoscopic Twin-Beam States for Underwater Quantum Communication

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Quantum resources have the potential to improve the secure transmission of information between two parties. Till now, Quantum Communication protocols have been implemented by means of entangled states produced at the single-photon level [1–3]. In contrast to that domain, where the presence of losses can reduce the transmission rate of information [4], in the mesoscopic one, the optical pulses contain sizeable numbers of photons, thus resulting in more robust against any kind of external degradation [5, 6]. In a recent work of ours, we have demonstrated that the transmission of one of the parties of a twin-beam (TWB) state through a lossy and noisy channel does not prevent the observation of nonclassical correlations between signal and idler arms [7]. Based on these successful results, here we consider a more realistic scenario in which one portion of TWB is sent through water-filled tubes while the other portion undergoes free-space propagation [8]. In particular, we investigate the role played by the length of the tubes, the number of optical elements inserted in the optical setup, and the divergence of the beams through the two different media. We demonstrate that, by properly acting on the light beams, we can still observe nonclassical correlations at moderate distances (> 2.5 m). The experimental implementations involve commercial photon-number-resolving detectors. In particular, hybrid photodetectors and Silicon Photomultipliers have been used and compared. Our results encourage the real exploitation of mesoscopic TWB states for underwater Quantum Communication protocols.

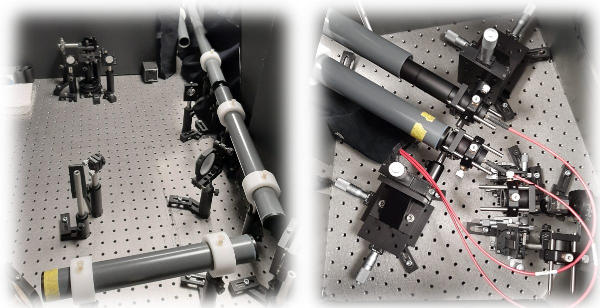

Figure 1: Left panel: Experimental setup involving water-filled tubes. Right panel: Collection of light from tubes into multi-mode fibers

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