Channel correction via heralded amplification

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Optical loss is one of the key roadblocks on the way towards large-scale quantum networks, and distributed quantum computing and sensings [1]. Loss-induced errors prevent the realization of the most sophisticated quantum protocols, including device-independent ones.

The effects of loss on quantum states can be reduced using probabilistic heralded amplification (HA) [2]. Amplifying the states directly is however not sufficient to overcome loss in quantum communication, because the amplified state is destroyed in cases when HA failed. In our realization of a loss-corrected quantum channel [3], we use HA to prepare a purified copy of entanglement. Upon the success of the operation, we use the purified entanglement as a resource to teleport the quantum state across the channel. We test our channel by using it to transmit entanglement via entanglement swapping through a large amount of loss and demonstrate genuine improved performance over direct transmission through loss, see Fig. 1, obtained without employing post-selection or post-processing of data. Our scheme is fully heralded and integrable into a large-scale quantum repeater network.

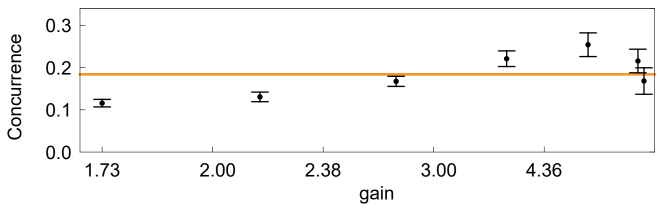

Figure 1: Amount of measured entanglement, characterized by concurrence, distributed directly through loss (line) and through the error-corrected quantum channel (dots) as a function of the amplification gain. The amount of added loss on the channel is $\approx 90\%$.

[1] S. Slussarenko and G. J. Pryde, *Appl. Phys. Rev.* **6**, 041303 (2019).

[2] G.Y. Xiang, T.C. Ralph, A.P. Lund, N. Walk and G.J. Pryde, *Nat. Photon.* **4**, 316 (2010).

[3] S. Slussarenko, *et. al.*, *Nat. Commun.* **13** 1832 (2022).