Survival of Mesoscopic Twin-Beam States Propagating in Lossy and Noisy Channels

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Quantum states of light represent a useful tool for encoding and transmitting information. The main obstacle to the successful implementation of Communication protocols, especially over long distances, is given by the losses and noise sources affecting the transmission channels, which can irreversibly change the statistical properties of the employed nonclassical light states [1].

In contrast to the usual schemes, based on single-photon quantum states [2–4], in our work, we show that mesoscopic twin-beam states of light exhibit very good robustness to both losses [5, 6] and noise sources [7].

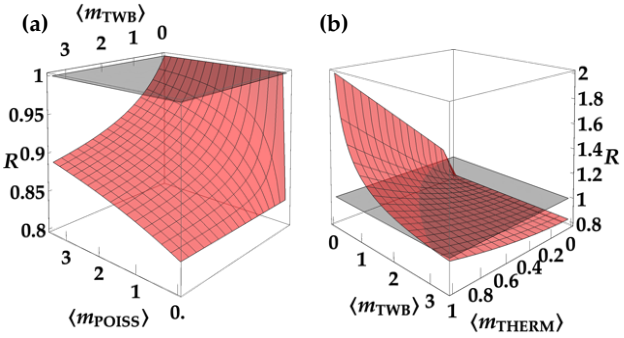

Figure 1: Noise-reduction factor as a function of the mean number of photons of the twin-beam state and the mean number of photons of the noise source when it is described by a Poissonian distribution (panel (a)) or by a single-mode thermal state (panel (b))

In particular, we present a thorough theoretical model that takes into account both the existence of an imbalance in the detection of the two parties of twin-beam states and the presence of additional noise in the communication channel. We demonstrate that it is possible to quantify the robustness of the quantum states by evaluating the noise reduction factor (see Fig. 1), which can be written in terms of the parameters describing the properties of the communication channel (loss + noise). We show that the experimental results obtained by adding a noise source (either a coherent or a pseudo-thermal one) to one of the two parties of twin beams are in excellent agreement with the model.

Our outcomes may therefore open new frontiers in the realization of Quantum Communication protocols.

References

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