Performance of Rotation-Symmetric Bosonic Codes in a Quantum Repeater Scheme based on Cavity-QED

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Long distance quantum communication will play a fundamental role in the future of quantum technologies [1, 2]. However, the photons traveling across optical fibers suffer from channel loss, making long-distance quantum communication challenging. To address this issue, quantum repeaters (QRs) had been devised [3, 4], which allows one to distribute entangled states ideally over distances ranging to from a few kilometers to hundreds of kilometers.

In this work, a quantum repeater scheme that resembles a third generation repeater protocol proposed recently in [5] is considered. This scheme relies on encoding the information into photonic logic states belonging to the rotation-symmetric bosonic codes (RSBCs). Such codes are invariant upon a rotation of a certain angle in phase space. This encoding has the nice property that is can increase the fidelity of the transmitted states through a series of interactions with atoms trapped within cavities. Further like all 3rd generation schemees, it does not require quantum memories since all the operations are made near instantaneously. In [5], the authors determine the performance of such a repeater scheme when the transmitted information is encoded into cat states, which also belong to the RSBC group. In this work, we extend this analysis to other RSBCs codes and then use them for the same quantum repeater scheme. Fig. 1 shows the performance of the squeezed cat codes and binomial codes comparing to cat codes. In Fig. 1a, it is shown that when the squeezed cat code is in use ($r > 0$), we can increase the elementary distance L_0 while keeping the value of the key rate similar or slightly above than the one of the cat code. Fig. 1b shows the comparison between the SKR of the cat code and binomial code versus the mean photon number for loss order $l = 7$ and for different elementary distances. The results indicate that incorporating squeezing can improve the performance of the quantum repeater scheme and binomial codes significantly outperform cat codes at the same loss order. In this talk, I will discuss in detail about the repeater protocol and the results.

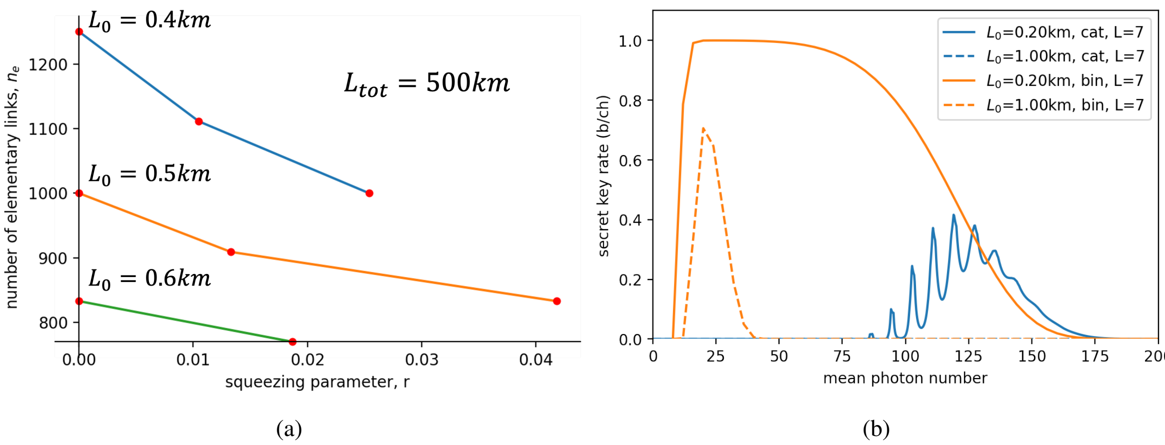

Figure 1: (a)The resources (n_e) needed to reach the target SKR with respect to r for total distance $L_{tot} = 500$ km. All the data points on the same curve achieve the same target SKR. By increasing the squeezing, less resources are required to achieve the same key rate. (b)The SKR for 7-loss cat code and 7-loss binomial code for various elementary distance L_0.

References

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