Lower Bounds for Capacities of Gaussian-like Channels: a Realistic Quantum Communication Scenario

Giuseppe Catalano

Abstract

All real systems are subjected to noise, which is not necessarily unique. Very often, in fact, the noise parameters can fluctuate and the best way to schematize this situation, on a physical and mathematical level, is to consider a system that evolves under a convex combination of channels, where each channel represents a possible noise acting on the system [1]. In this way, it is possible to construct a more realistic model of noise, and the greater the number of channels involved, the better will be the approximation.

In my thesis, I studied the Entanglement Assisted Classical Capacity (EACC) of a convex combination of two lossy channels. In order to model the action of noise, I added to the environment an ancillary system that, with appropriate coupling, selects one or another channel in the convex combination.

In future research, I would like to generalize the theoretical and computational methods proposed in the thesis in order to study the Classical Capacity (CC) and the Quantum Capacity (QC) for the case under consideration of two lossy channels in convex combination. Moreover, I would like to deepen and further generalize the results obtained in my thesis regarding EACC and the ones to be obtained regarding CC and CQ, in order to study an integral combination of lossy channels, that represents a good model of a more complex noise, such as that caused by the atmosferic interactions. This latter situation represent, in fact, a more realistic scenario that could be of interest in quantum communication protocols, involving, for example, the transmission of quantum information through satellites. To address this problem, it is possible to approximate the integral as a summation, to have a convex combination of lossy channels and apply the methods developed in the thesis to find a Stinespring representation of the channel itself. Given the Stinespring representation of a channel, it is easy to find the expression of the complementary channel. This allows finding the exchange entropy, which is a bottleneck in the calculation of the EACC and QC. Once found the expressions of the entropic functionals that have to be maximized to find the values of the capacities, it is possible maximizing them using iterative or perturbative methods.

References

[1] László R. et al., Fading channel estimation for free-space continuous-variable secure quantum communication, *New Journal of Physics*, **21**, 123036 (2019).