Disturbance of Operation in Quantum Estimation for Noised Coherent Light

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1 Motivation

For a thermal noise model of the coherent light, Hayashi [1] proposed a quantum operation and a quantum measurement to estimate the location and the scale parameters of the Gaussian P-function, and showed that the estimators are unbiased, asymptotically consistent and asymptotically optimal. His operation needs to use beam splitters of the required transparency to change the quantum state of given independent samples. However, in actual situations of physical experiments, it may be difficult to prepare beam splitters of the ideal transparency for the planned quantum operations, and if we use such disturbed beam splitters, the result of operation and measurement will not be what we would really like to obtain.

2 Results

In this poster, we analyze the disturbance of transparency of beam splitters for Hayashi's quantum operation assuming that the transparency of a beam splitter is a Gaussian random variable independent of each other. We show that the disturbance makes the estimators of the location and scale parameters of the Gaussian P-function biased and asymptotically inconsistent. We also propose a way to correct the bias of estimators when the variance of the random transparency is known.

In addition, we review Hayashi's problem of Gaussian P-function. We first extend Hayashi's problem to the case that the P-function is not Gaussian. Then, we extend it to the case that the transparency of beam splitters is randomized. In addition, we correct the bias of Hayashi's estimators. Finally, the mean squared errors of estimators are compared numerically.

References

[1] Hayashi, M. (2000). Asymptotic quantum theory for the thermal s tate family. *Quantum communication, computing and measurement 2* (edited by Kumar, P. D'ariano, G. M. and Hirota, O.), Plenum, New York, 99-104.