Continuous variable quantum teleportation via entangled Gaussian state generated by a linear beam splitter

Haleema Sadia Qureshi[1], **Shakir Ullah**[1,2,*], and Fazal Ghafoor[1]

[1]*Department of Physics, COMSATS University Islamabad, Islamabad Campus 45550, Pakistan*

[2]Present address: *Institute of Nuclear Sciences, Hacettepe University, 06800 Ankara, Turkey*

*shakirullah@hacettepe.edu.tr

Introduction

Aim: We theoretically implement the protocol of continuous variable (CV) teleportation [1].
Novelty: Using the nonclassicality and purity of the general TSMGSs employed initially to the beam splitter, the unknown state teleportation is implemented in terms of squeezing and phase space quadratures [1].
Importance: CV teleportation play pivotal role for the practical realization of QC and QIP.

Model Formulation

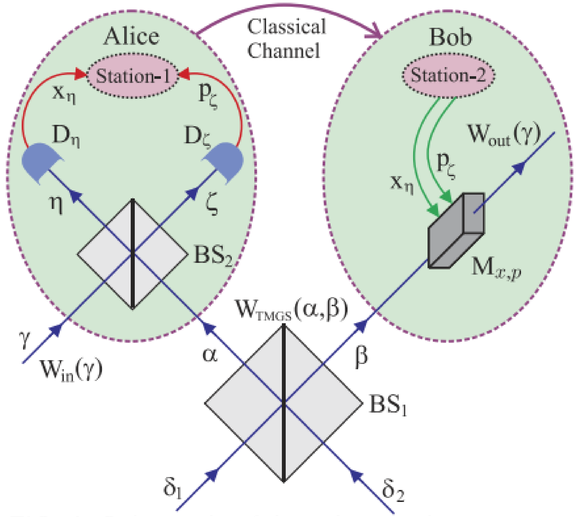

FIG. 1: Schematic of the teleportation process.

Input and output Covariance Matrices:

$$V_{\text{in}} = \begin{pmatrix} V_1 & 0 \\ 0 & V_2 \end{pmatrix} \qquad V_{out} = \begin{pmatrix} \mathbb{V}_1 & \mathbb{V}_3 \\ \mathbb{V}_3^T & \mathbb{V}_2 \end{pmatrix}$$

Fidelity [2]: $F = \pi \int \mathrm{d}^2\beta W_{\text{in}}(\beta)\, W_{\text{out}}(\beta)$

Results and Discussions

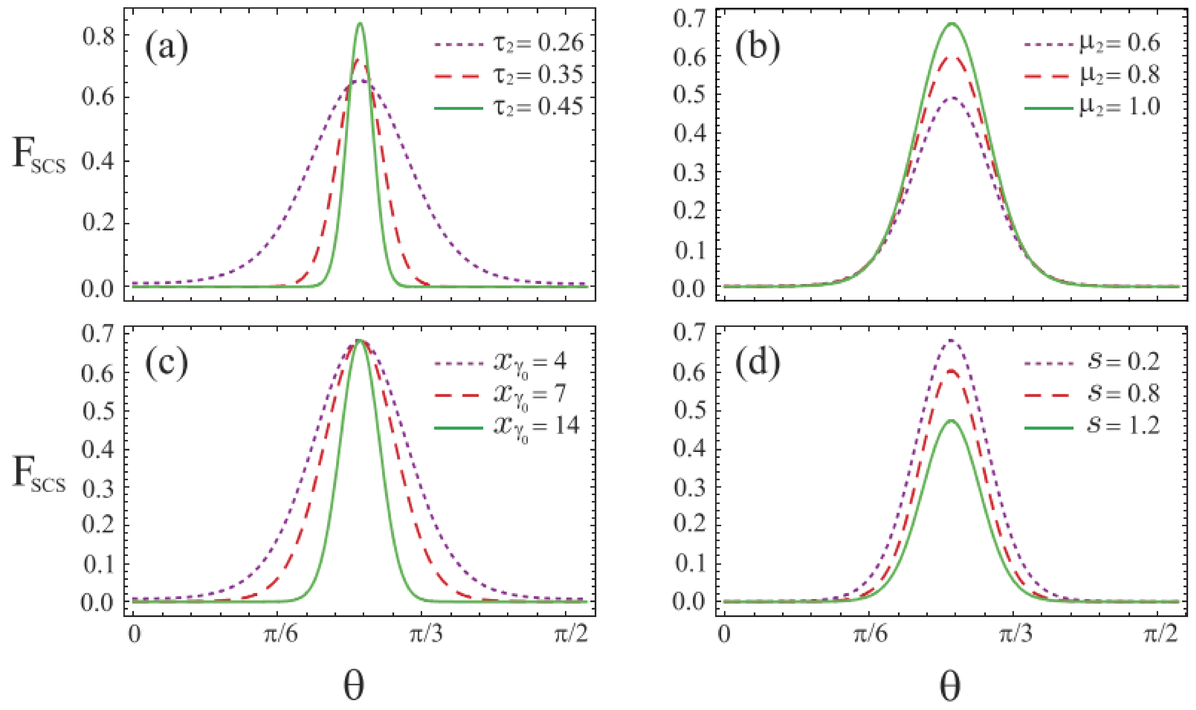

FIG. 2: The fidelity F_{SCS} of the teleported squeezed coherent state is plotted versus angle θ of the BS_1 with various parameters of the system. (a) $\mu_1 = \mu_2 = 1$, $\tau_1 = 0.1$, $x_{\gamma_o} = p_{\gamma_o} = 7$, and $s = 0.2$. (b) $\tau_1 = 0.1$, $\tau_2 = 0.3$, $x_{\gamma_o} = p_{\gamma_o} = 7$, and $s = 0.2$. (c) $\mu_1 = \mu_2 = 1$, $\tau_1 = 0.1$, $\tau_2 = 0.3$, $p_{\gamma_o} = 7$, and $s = 0.2$. (d) $\mu_1 = \mu_2 = 1$, $\tau_1 = 0.1$, $\tau_2 = 0.3$, and $x_{\gamma_o} = p_{\gamma_o} = 7$.

a) The maximum of the fidelity increases with increase in the non-classicality of the input states.
b) The fidelity enhances with purity in the entire regime of *θ* except for *0* and *π/2*.
c) The line-width of the fidelity sharpens when any of phase space quadratures (*x* or *p*) of the squeezed coherent state with Alice increases.
d) Maximal fidelity requires minimal squeezing in the desired input state, since the squeezing parameter decreases the efficiency of the quantum state teleportation.

Fidelity of Coherent State

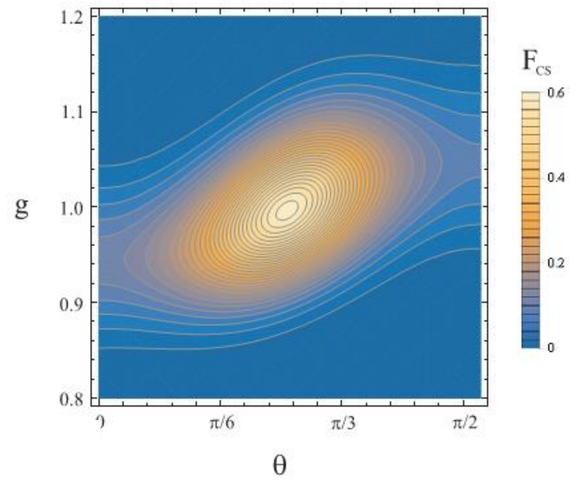

FIG. 3: The fidelity F_{CS} of the teleported coherent state is plotted versus gain parameter g and angle θ of the BS_1 using fixed values of $\mu_1 = \mu_2 = 1$, $\tau_1 = 0.1$, $\tau_2 = 0.2$, $x_{\gamma_o} = 6$, $p_{\gamma_o} = 18$ and $\phi_1 = \phi_2 = \varphi = 0$.

Reference

1. H. S. Qureshi, **S. Ullah**, and F. Ghafoor, J. Phys. B: Atm. Mol. Opt. Phys. **53** 135501 (2020).
2. S. L. Braunstein and H. J. Kimble, Phys. Rev. Lett. **80**, 869 (1998).

Acknowledgments

I gratefully thank Mehmet Emre Tasgin for valuable discussions. For financial support, I acknowledge TUBITAK Project Grant No. 121F141.

Further information

DOI: https://doi.org/10.1088/1361-6455/ab8b44
ORCID: https://orcid.org/0000-0002-7371-7884