Bidirectional quantum teleportation of even and odd coherent states through the multipartite Glauber coherent state: Theory and implementation

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(Dated: June 2, 2023)

Quantum teleportation has become a fundamental building block of quantum technologies, playing a vital role in the development of quantum communication networks. Here, we present a bidirectional quantum teleportation (BQT) protocol that enables even and odd coherent states to be transmitted and reconstructed over arbitrary distances in two directions. To this end, we employ the multipartite Glauber coherent state, comprising the Greenberger-Horne-Zeilinger, ground and Werner states, as a quantum resource linking distant partners Alice and Bob. The pairwise entanglement existing in symmetric and antisymmetric multipartite coherent states is explored, and by controlling the overlap and number of probes constructing various types of quantum channels, the teleportation efficiency of teleported states in both directions may be maximized. Besides, Alice's and Bob's trigger phases are estimated to explore their roles in our protocol using two kinds of quantum statistical speed referred to as quantum Fisher information (QFI) and Hilbert-Schmidt speed (HSS). Specifically, we show that the lower bound of the statistical estimation error, quantified by QFI and HSS, corresponds to the highest fidelity from Alice to Bob and conversely from Bob to Alice, and that the choice of the pre-shared quantum channel has a critical role in achieving high BQT efficiency. Finally, we show how to implement the suggested scheme on current experimental tools, where Alice can transfer her even coherent state to Bob, and at the same time, Bob can transfer his odd coherent state to Alice.