Teleportation of a genuine single-rail vacuum/one-photon qubit generated via a quantum dot source

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Quantum state teleportation represents a pivotal result of the quantum information theory and one of the essential protocols for the creation of quantum networks.
In the literature there are several photonic implementations of the protocol for different degree of freedoms [1-2], however until now there are no implementation in the single mode vacuum/one-photon encoding.

Previous attempts to use this particular encoding led to the implementation of the entanglement swapping protocol [3] since maximally entangled states in such an encoding can be generated through the use of a beam splitter. In contrast, the teleportation protocol results more challenging since the difficulty of creating generic single mode vacuum/one-photon state.

In this work [4], we present the genuine implementation of a quantum teleportation protocol in single-rail vacuum/one-photon coding using a quantum dot-based single photon source coherently controlled in a micro-cavity. Indeed, it has recently been experimentally demonstrated how this type of source allows the creation of superposition states of vacuum and single photons [5].
Furthermore, with the same apparatus we demonstrate the implementation of an entanglement swapping protocol using the time-bin encoding.

Our results disclose new applications and potentialities for the single-rail vacuum/one-photon encoding in the quantum information and quantum communications.

References

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Figures

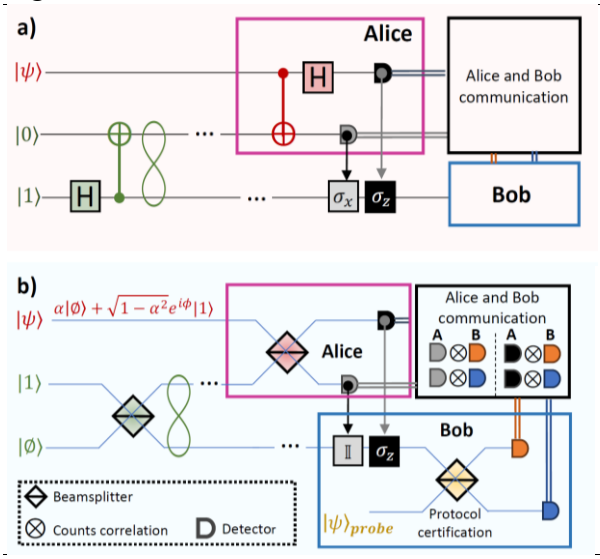

Figure 1: Conceptual scheme of the protocol [4]