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Total Teleportation of an Entangled State

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We propose a linear-optical scheme to directly and totally teleport an entangled state. As pointed out by Bennett et al.[1] in their original proposal for teleportation, entanglement can be transferred through teleportation of the state of one member of the entangled pair. This method, known as entanglement swapping, provides partial teleportation of entanglement in the sense that the teleported state is only a part of the entangled state. We present an alternative method in which the entire entangled state is transferred directly from one place to another.

We consider the case where the entangled state to be transferred is a single-photon entangled state[2], which may, for example, be generated by directing a single photon to a beam splitter of unknown reflection and transmission coefficients. At the source station we need to have a parametric downconversion source that emits a pair of entangled photons, which emerge through two of the four output ports connected to the source. These photons in a two-photon entangled state provide the quantum channel. The sending station is equipped with a dual Bell measurement system with two beam splitters and two pairs of detectors. We show that, using this scheme, the single-photon entangled state can be directly transferred with a 50% probability of success. By a straightforward generalization of the scheme, total teleportation of a multi-particle entangled state can also be realized.

REFERENCES

[1] C. H. Bennett, et al., Phys. Rev. Lett. **70**, 1895 (1993).
[2] H. W. Lee and J. Kim, Phys. Rev. A **63**, 012305 (2001).