Quantum Teleportation with Photons

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Abstract

One of the goals of quantum information processing is the transfer of an unknown state of one quantum system onto another over an arbitrary distance. This can be achieved by making use of the quantum teleportation protocol.
We will introduce the quantum teleportation protocol as presented in the paper by Bouwmeester et al. [1], in which they also demonstrate the first experimental realization of quantum teleportation. After discussing the experimental particularities arising from the use of photons as the information carriers, we will study their line of thought used to show that teleportation took place. The results support a successful teleportation rate of 70%. This paper shows the feasibility of performing quantum teleportation and lays the groundwork for probing teleportation over long distances. This is shown nicely in the work done by Ma, et al., which demonstrates teleportation of independent quantum states over 143 kilometer optical free-space channels [2]. We will discuss their setup, difficulties arising due to real-world conditions and their results, demonstrating fidelities exceeding the classical limit of 2/3 [3]. This long-distance quantum teleportation forms a building block for ground-to-satellite quantum communication; the first step to a global quantum network.

1. Dik Bouwmeester, Jian-Wei Pan, Klaus Mattle, Manfred Eibl, Harald Weinfurter & Anton Zeilinger, *Experimental quantum teleportation,* Nature **390**, 575 (1997).
2. Xiao-Song Ma et al., *Quantum teleportation over 143 kilometres using active feed-forward,* Nature **489**, 7415 (2012).
3. Serge Massar & Sandu Popescu, *Optimal extraction of information from finite quantum ensembles,* Phys. Rev. Lett. **74**, 1259(1995).