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Invitation

A Teleportation-Based C-NOT Gate for Fault-Tolerant Quantum Computation

Alexander Göbel
Physikalisches Institut, Universität Heidelberg

Quantum computers promise dramatic speed ups for many computational tasks. For large scale quantum computation however, the coupling of physical qubits to the environment imposes a major challenge for a real-life implementation. The teleportation-based scheme proposed by Gottesman and Chuang allows for realizations of universal quantum gates for quantum computation in a fault-tolerant manner. We report an proof-of-principle implementation of this architecture by demonstrating a teleportation-based two-qubit controlled-NOT (C-NOT) gate through linear optics with a six-photon interferometer. We prepare a two-photon input, which can be in a completely random state together with a four-photon cluster state used as the working base. The information of the input-qubits is then transferred onto the cluster state via two separate Bell-state measurements. The two-photon output is ready to use and is verified by measurements in three orthogonal basis. The obtained results clearly proof the involved working principles and the entangling capability of the gate. Our experiment could represent an important step towards the feasibility of realistic quantum computers and could trigger many further applications in linear quantum optics.
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Grosser Hörsaal
Atominstitut der Österreichischen Universitäten
Stadionallee 2

J. Schmiedmayer