

Abstract for an Invited Paper  
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**Beller Lectureship Recipient Talk: Applications of Quantum Teleportation<sup>1</sup>**

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Quantum teleportation, a way to transfer the state of a quantum system from one location to another, is central to quantum communication and plays an important role in a number of quantum computation protocols. Previous experimental demonstrations have been implemented with single photonic or ionic qubits. Very recently long-distance teleportation and open-destination teleportation have also been realized. Until now, previous experiments have only been able to teleport single qubits. However, since teleportation of single qubits is insufficient for a large-scale realization of quantum communication and computation, teleportation of a composite system containing two or more qubits has been seen as a long-standing goal in quantum information science. In my talk, I shall present the first experimental realization of quantum teleportation of a two-qubit composite system. In the experiment, we develop and exploit a six-photon interferometer to teleport an arbitrary polarization state of two photons. Not only does our six-photon interferometer provide an important step towards teleportation of a complex system, it will also enable future experimental investigations on a number of fundamental quantum communication and computation protocols such as multi-stage realization of quantum-relay, fault-tolerant quantum computation, universal quantum error-correction and one-way quantum computation.

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